Aligning Climate Change Mitigation and Agricultural Policies in Eastern Europe and Central Asia

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Abstract

Greenhouse gas emissions are largely determined by how energy is created and used, and policies designed to encourage mitigation efforts reflect this reality. However, an unintended consequence of an energy-focused strategy is that the set of policy instruments needed to tap mitigation opportunities in agriculture is incomplete. In particular, market-linked incentives to achieve mitigation targets are disconnected from efforts to better manage carbon sequestered in agricultural land. This is especially important for many countries in Eastern Europe and Central Asia where once-productive land has been degraded through poor agricultural practices. Often good agricultural policies and prudent natural resource management can

compensate for missing links to mitigation incentives, but only partially. At the same time, two international project-based programs, Joint Implementation and the Clean Development Mechanism, have been used to finance other types of agricultural mitigation efforts worldwide. Even so, a review of projects suggests that few countries in Eastern Europe and Central Asia take full advantage of these financing paths. This paper discusses mitigation opportunities in the region, the reach of current mitigation incentives, and missed mitigation opportunities in agriculture. The paper concludes with a discussion of alternative policies designed to jointly promote mitigation and co-benefits for agriculture and the environment.

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I. Introduction

Greenhouse gas emissions are primarily determined by how energy is created and used. Necessarily, policies to slow climate change focus on this dominant source. However, discussions centered on the energy sector frame policy tradeoffs in general terms that can obscure differences among sectors and can lead to policy instruments that do not suit significant but less dominant sectors. This is especially true for agriculture where complementary relationships among mitigation activities, agricultural productivity, climate resiliency and resource management are key. Specifically, mitigation activities in the agricultural sector often generate co-benefits of various kinds. Sometimes, the mitigation benefits of the activity dominate and general climate change instruments work well. Often however, large co-benefits are associated with mitigation activities and when this is the case, general climate change instruments by themselves may be insufficient for good policy.

An example of this dichotomous set of policy outcomes is found in the types of projects that emerged from the two Kyoto project investment mechanisms, Joint Implementation (JI) and the Clean Development Mechanism (CDM). As we explore in this paper, the twin mechanisms have proven effective in mobilizing private investment in mitigation activities in general and have worked well for certain types of bio-energy projects in the agricultural sector. In contrast, other mitigation activities, especially those related to how land is used, are poorly suited for the program and largely absent. This matters since there is abundant potential for both types of mitigation projects worldwide and especially in Eastern Europe and Central Asia (ECA).

A related consequence of a climate change policy debate centered on energy has to do with real and perceived tradeoffs. Because changing the way energy is produced and used is costly, economic growth and climate policies are linked as competing objectives, and comparisons of policy instruments are cast in terms of lost growth.¹ This characterization obscures areas where tradeoffs are not stark and can encourage entrenched positions that preclude progress on any front.

While policies designed to tap significant mitigation and adaptation opportunities in agriculture fit uneasily within a general policy framework for climate change, components of a good agricultural policy framework often contribute to mitigation and adaptation objectives, even when such objectives are not a policy priority. For example, promoting institutions that secure land rights can help promote sustainable land management practices and investing in agricultural research can boost land productivity. Both are key components of a sound agricultural policy since they can help improve the livelihoods of the rural poor and help protect valuable core environmental resources. Both also work to boost the sequestration of carbon in soils and forests and help improve the reliance of the agricultural sector to forecasted changes in climate. Still, even when policy makers actively promote these types of actions within agricultural policy, incentives to fully pursue such activities will be of a second-best nature and likely fail to elicit the scale of investment that a full accounting of benefits would bring.

¹ For example, a recent report, the European Bank for Reconstruction and Development (EBRD 2011, p27) estimates that achieving a goal of 500-550 ppm CO₂e would reduce the GDP of ECA economies by about 5.7 percent for the period 2010-2050, compared to a business-as-usual counterfactual. The estimated costs are higher for the transitional economies of ECA at about 8.3 percent for oil-exporters and about 6.2 percent for the non-oil exporters.

As we discuss later in the paper, much scope remains to extend the reach of the current climate change policy framework – especially in promoting CDM and JI investments. In addition, there are areas where improved agricultural policies and resource management policies could promote mitigation and adaptation objectives, especially in the area of land rights and land management. And there are old and new sources of financing that could be tapped to devise domestic policies and activities that jointly pursue mitigation, adaptation and agricultural productivity goals. Even so, there is also scope for parties to the UNFCCC to take action that recognizes the special features of the agricultural sector and remedies shortcomings in the current agreement.

The remainder of the paper is organized as follows. In the next section we examine sources of greenhouse gas emissions in the ECA region and the world. Section III looks at mitigation opportunities in the region. Section IV examines the policy environment that shapes decisions about which mitigation opportunities in agriculture are tapped and examines project investment outcomes. Section V looks at how policies, project characteristics and markets work to favor some types of investments over others. Section VI discusses the set of ancillary benefits that come with land-use mitigation activities. Section VII describes the potential for finding complementary climate change and resource management policies to promote two complementary sets of mitigation activities in agriculture. A final section concludes.

II. Sources of greenhouse gas emissions

The ECA region is a significant emitter of greenhouse gases, with combined emissions in excess of 4 billion tons CO₂ equivalent (GtCO₂e) in 2005, or roughly 12 percent of global emissions, according to estimates from the World Resource Institute (WRI 2011). This is comparable to the emissions from Western Europe for the period and greater than the emissions from Latin America (table 1.) Emissions are relatively high on a per capita basis as well, averaging about 9.6 tons CO₂e (tCO₂e) per capita in 2005. This is well below the US-Canadian average of 23.3 tons, but well above the Latin American per capita average of 5.4 tons. Emissions fell sharply as the economies of ECA restructured following the dissolution of the Soviet Union from 14 tCO₂e per capita in 1990 to 9.1 tCO₂e per capita in 2000, only to climb slightly from 2000 to 2005.

As with most regions, the energy sector accounts for most of the region's emissions – about 85 percent in 2005. In this respect, the sector composition of emissions is similar to Western Europe. Agriculture accounts for 16 percent of global emissions, although this accounting excludes net changes to sequestered carbon due to land-use – a topic to which we return later. Within the ECA region, agriculture's role is smaller and accounts for about 9 percent, a share similar to agriculture's 10 percent share in Western Europe (figure 1). Most ECA emissions (74 percent) are in the form of carbon dioxide (figure 2). At around 20 percent, methane's share of emissions in ECA is more than twice as high as its share in Western Europe and about two-thirds of the gas' share of emissions in Latin America. Though the overall level of emissions has changed significantly since 1990, the aggregate composition of emissions by sector and gas have remained broadly constant over time, as has been the case with global emissions in general (table 2).

The countries in the ECA region comprise a set of highly diverse economies, which is reflected in the scale of emissions for the countries (table 3). Measured in the aggregate, emissions from the Russian Federation dwarf those from other countries in the region. However, a different picture emerges once the emissions are scaled by population (table 4). Per capita emissions are similar in Turkmenistan, Estonia, the Czech Republic, the Russian Federation and Kazakhstan. The figure and graphs also show how differences in the relative emission-intensity of the countries over time, with per capita emissions falling rapidly in many ECA countries.

Because a few countries produce most of the region's greenhouse gas emissions, regional averages mask a greater variation in the composition of emission sources at the country level and differences in how emissions

have changed over time. In general, sectors other than energy and gases other than CO₂ are less important sources of emissions. However, in some countries emissions from agriculture are an important source of total emissions and this affects the composition of greenhouse gases by type of gas.

More than half of the methane and more than 80 percent of the nitrous oxide released into the atmosphere by human activities originate in agriculture. Both are potent greenhouse gases, with a ton of methane equivalent to 23 tons of carbon dioxide and a ton of nitrous oxide equivalent to 296 tons of carbon dioxide in the short run. Consequently some types of agricultural activities, especially those related to how manure and other agricultural wastes are managed, have a disproportionate effect on aggregate greenhouse gas emissions from the sector. Consequently agriculture is a significant contributor to GHG emissions in places like Albania, Georgia and Tajikistan, where methane and nitrous oxide emissions are relatively high. (See table 5.)

A key characteristic of the region has been the structural realignment of the region's economies. This is reflected in the changing composition of emissions by sector and by the type of gases emitted. Figure 3 shows the relationship between agricultural income, methane and nitrous oxide. Figures 4 and 5 show how the composition of emissions changed between 1990 and 2005. Figure 4 shows the percentage change by country by type of gas and figure 5 shows the same type of information by emitting sector.² The two are related. For example, figure 4 shows that carbon dioxide emissions fell by nearly 50 percent in Albania while methane and nitrous oxide emissions rose. Figure 5 shows that emissions from the energy fell significantly – a sector that mostly emits CO₂ – while emissions from agriculture – a sector that produces significant quantities of methane and nitrous oxide emissions – grew.

III. Mitigation opportunities³

In this section we examine potential mitigation opportunities for agriculture in the ECA region. Broadly, mitigation potential is an economic concept associated with the cost of sequestering greenhouse gases or avoiding greenhouse gas emissions. It is a key feature of mitigation assessments, including those produced by the Intergovernmental Panel on Climate Change (IPCC)⁴. Mitigation opportunities are calculated against a counter-factual scenario, usually a forward-looking projection based on a continuation of existing practices and policies. The assessments often rely on models built up from estimates of the costs of deploying different production technologies, shifting consumer preferences, and encouraging activities that permanently store greenhouse gases. Typically, this results in a schedule, called a marginal abatement cost (MAC) curve, that relates feasible mitigation opportunities with a range of “carbon prices,” where the prices of carbon indicates a value that would cover the investment and other costs associated with marginal reductions in emissions vis-à-vis a baseline counter-factual.

In 2007 the IPCC reviewed projections across a range of modeling efforts to assess potential sources of mitigation by sector (Barker et al., 2007). Table 6 summarizes the report's assessment of mitigation opportunities at US\$20 per tCO₂e.⁵ The assessment reports that global mitigation opportunities are greatest in the building, industry and agricultural sectors. Moreover, the report concludes that most energy-saving efforts in the building sector are “win-win” opportunities – that is, investments related to the identified improving energy efficiencies in buildings would be profitable without additional carbon payments. Because

² Gases of all types are expressed in terms of CO₂ equivalents.

³ This section draws partly on material published in Larson, Dinar and Aapris (2011).

⁴ The IPCC is a scientific body, established by the United Nations Environment Program and the World Meteorological Organization, to develop an expert view about the causes and consequences of climate change.

⁵ By convention, measures of greenhouse gas emissions cover the six Kyoto Protocol gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). Aggregate emission and mitigation amounts are expressed in terms of CO₂e, the amount of CO₂ needed to produce the same global warming potential.

“win-win” projects are ineligible under most domestic and international payment-based mitigation programs, this suggests that the agricultural sector should feature prominently under policy regimes that encourage payments for mitigation efforts. As we discuss later, this is not the case.

As the agricultural chapter of the IPCC report makes clear, the consensus estimate of 1.6 GtCO₂e in mitigation potential is based on models in which the agricultural sector is narrowly defined, focusing on on-farm activities primarily involving crops and livestock and the handling of animal wastes (Smith et al., 2007). As a consequence, additional opportunities linked to the use of organic agricultural wastes, such as bagasse or rice husks, as a renewable fuel are not counted toward reported mitigation potentials in agriculture, but are attributed to sectors in which the fuel-switching takes place. Top-down studies referenced in the report suggest that this class of opportunities for mitigation is nearly as large as agriculture’s on-farm potential, with mitigation estimates ranging from 0.7 to 1.26 gtCO₂e per year by 2030 at costs of US\$20 or below.

The mitigation potential from changing how agricultural land is used is included in the IPCC estimates. However, as Smith et al. (2008) emphasize, measuring the mitigation potential for agricultural land-use is complex because a single activity can initiate a chain of emission outcomes among a portfolio of greenhouse gasses that also depend on local soils and local climate conditions. As an example, the authors cite evidence presented in Paustian et al. (2004) showing that composting manure can suppress methane emissions while simultaneously accelerating emissions of another greenhouse gas, nitrous oxide. Similarly, soil restoration can encourage carbon uptake in plants and soils, while stimulating the release of carbon through the decomposition of organic matter.

After accounting for interrelated effects, the authors provide a further breakdown of the mitigation potential for a set of agricultural activities under a range of carbon prices, shown in figure 6. Keeping in mind that mitigation activities linked to agricultural biomass are excluded, the reported literature suggests that most mitigation opportunities are related to soil and land management practices that generate net sequestration gains. At low carbon prices (less than US\$20), cropland management practices are key sources of mitigation, along with other land management practices, including the restoration of organic soils, degraded lands and improved management of grazing.

It is worth emphasizing that the types of mitigation activities identified are those often undertaken to enhance agricultural productivity or better manage agricultural resources even when mitigation incentives are absent. In particular the report notes that improved agronomic practices designed to improve yields, such as expanding crop rotations or adding nutrients when they are deficient, can lead to greater carbon sequestration in soils. Utilizing vegetative cover between rows of trees or vines both protects against erosion and enhances carbon storage. The authors also note that improved nutrient management on crop and grazing land can sequester carbon while holding down production costs. Adding organic matter or controlling erosion in order to restoring degraded lands increases the stock of land usable for agriculture and while stockpiling carbon in the soils. Smaller but important mitigation opportunities are tied to efforts designed to reduce methane emissions from wetland rice, livestock and manure.

The IPCC report provides estimates of the full set of technically feasible mitigation potential from agriculture by region, but does not further distinguish among the projects by cost. The mean estimates for selected regions are given in figure 7. For ECA, the mean estimated technical potential mitigation is about 781 million tonsCO₂ equivalent (MtCO₂e) per year by 2030, which works out to more than 13 percent of the estimated mitigation potential of agriculture world-wide.

Soil carbon pools

In 1982, Post and colleagues (1982) estimated that soil organic carbon contains about two-thirds of the carbon in terrestrial ecosystems. This is a remarkable figure and it is perhaps surprising that the preservation of rich carbon pools have not garnered greater attention. There are several shared characteristics between below-ground carbon pools and above ground forests that are important for policy. Often forests and carbon pools are situated on lands where use rights are unclear and access to the resources are not easily limited by governments or private groups. In addition, while both land restoration and reforestation were included as features of early climate change treaties, including the Kyoto Protocol, the preservation of forests and carbon pools were not. To date, while the so-called REDD (Reducing Emissions from Deforestation in Developing Countries) agenda is expected to be a key component of post-2012 climate change treaties, the preservation of carbon in soils has been given less political urgency.⁶

A geographic dataset of organic carbon pooled in the topsoil constructed by FAO-UNESCO (2007) shows that immense stores of carbon are held in ECA's soils (Map 1). The Russian Federation has vast areas of relatively high-carbon pools most notably in the boreal forests of Siberia and nearby environments. In addition, Central Asia has a few carbon hotspots surrounded by relatively lower concentrations of soil carbon. Eastern Europe is mixed with all categories of terrain represented.

FAO (2010) also produced a dataset on land use, based on data from 1998-2008 (Map 2). A closer look at land use map reveals large forest area in the north and large area of crops and agriculture in mid-latitudes and the Eastern Europe. Central Asia has a few hotspots of agricultural and crop use.

By combining the two datasets, it is possible to say something about how the land containing carbon pools is used and managed. Aggregated data for the region as a whole is reported in Table 7.7 Measuring the carbon content of soils is difficult, but the FAO estimates indicate the scale of the carbon pools in ECA. Overall, topsoils in ECA are estimated to contain the carbon equivalent of consuming 428 to 933 billion barrels of crude oil.⁸

According to FAO's classification, roughly 47 percent of the area is used for agricultural purposes, and only about 24 percent is used for moderate to high intensity crop or livestock activities. FAO estimates that topsoil carbon contained in land put to these agricultural purposes ranges from 20,735 to 46,694 million tons of carbon (MtC), or roughly, 37-39 percent of the total. Remarkably, more than half the soil carbon is contained in soils that are unmanaged. Moreover, of the 28 to 60 thousand MtC of carbon in unmanaged soils, roughly half is contained in the soils beneath unprotected virgin forests. This means that policies aimed at protecting forests will have an additional benefit for climate change since the policy would also protect the soil contained in forest floors. Still, even if virgin forests received adequate protection, roughly 25 percent of the of the region's large reserves of soil carbon would remain in land that is neither managed by farmers nor protected in forests.

Russia and Turkey

In this section, we examine differences in the composition of mitigation opportunities in Turkey and Russia, the two largest economies in the region, to illustrate how agriculture's role in the economy and its potential role in a country's mitigation strategy can differ. Both economies are of similar size; Turkey's GDP averaged

⁶ See Lal (2009) for a good discussion of the links between soil carbon and land use. See CBD (2009) discussion on the need to link forest, biodiversity and land-use policies.

⁷ FAO's original categories were aggregated to produce the table and the key to the aggregation is given in Annex table 1. The data is given at a country level in Annex table 2.

⁸ Based on EPA (2007) estimates that 1 ton of carbon is emitted for every 7.7 barrels of crude oil consumed. To lend perspective, the IEA (2012) estimates that global consumption of crude oil equaled 32.5 billion barrels in 2011.

about \$US 359 billion, adjusted to 2000 dollars, between 2005 and 2009, while Russia's averaged \$394 billion. At 8 percent, agriculture's share of GDP for the period in Turkey was slightly larger than in Russia where it was 5 percent. However, a recent report by the European Bank for Reconstruction and Development (EBRD, 2011) suggests there may be much greater mitigation potential for agriculture and forestry in Russia than in Turkey.

Based on input from McKinsey and Company, National Economic Research Associates, and Bloomberg New Energy Finance, the IBRD study reports marginal abatement curves for Turkey and Russia. The MAC curves rely on the assumptions that the policy frameworks in both countries remain unchanged from 2009 to 2030, the period of the analysis. They were built-up using country-specific sector practices and show, on a per ton basis, the incremental cost of switching from a status-quo technology to a less polluting one. Results from selected portions of the baseline MACs for each country are given in figures 8 and 9. The figures report the annualized abatement potentials by 2030 for three low-cost ranges: win-win opportunities where the costs associated from switching technologies are covered from future savings – for example, reduced energy expenditures. The second category includes the mitigation potential associated with low-positive carbon prices, ranging from zero to €20 per tCO₂e. The next category shows the mitigation potential triggered by carbon prices ranging from €20 to €100 per tCO₂e.

More than 40 million hectares, or roughly 52 percent of Turkey's land area is devoted to agricultural uses (FAO, 2011). Yet a striking feature of the figure for Turkey is the relative lack of significant mitigation opportunities in agriculture, despite agriculture's significant role in the economy and the landscape. The combined potential for the sector for costs of €100 per tCO₂e and below is estimated to be a mere 1.52 MtCO₂e.

Although a smaller share of Russia's land is devoted to agriculture (about 13 percent), the scale of Russia's landscape is vastly different, with nearly 215 million hectares of land used for agricultural purposes. Moreover, the identified potential within the agricultural sector is also of a different scale; the study identifies more than 149 MtCO₂e in mitigation potential from the sector. Much of the potential identified for the economy as a whole falls into the win-win category of activities that can be financed via cost savings – including nearly 40 MtCO₂e in agriculture. Moving to the low-cost category, most identified projects are in agriculture and forestry, at 108 and 228 MtCO₂e respectively. Moreover, the potential in forestry and agriculture are closely linked. Of the low-cost sources of mitigation, more than 80 MtCO₂e of agricultural potential is related to managing or restoring soils; of the forestry projects, more than 141 MtCO₂e are based on the afforestation and another 33 MtCO₂e comes from converting land to agro-forestry purposes. As we explain below, there is great potential for restoring degraded land in many other ECA countries as well.

Land use, agronomy, livestock waste and aligned resource management objectives

The example of Russia highlights the strong links between mitigation potential and agricultural resource use. Returning to the IPCC report, the study identifies three core areas for low cost mitigation opportunities in agriculture: i) improving agronomic practices; ii) improving land management and restoring degraded lands; and iii) better managing of animal waste products. In this section we look at these types of activities in the context of the ECA countries.

Degraded lands

In 2000, FAO conducted an analysis of lands degraded by agriculture and other human activities. Totals from that report are shown in figure 10 for ECA and other regions (FAO, 2000). In total, degraded land in ECA accounted for 6.8 million km², an area one-and-a-half times the agricultural area of the United States.⁹ About

⁹ FAO (2011) reports agricultural area in the United States in 2008 equaled 4.04 million km².

24 percent of the land degradation is attributed to poor agricultural practices. Table 8 gives a breakdown by country. Dominated by the Russian Federation, the scale of land degraded by agricultural practices is remarkable, with an estimated 100 million hectares in Russia and another 11 million hectares in the relatively small country of Romania. The problem is endemic for the region as a whole, as Map 3 illustrates.

A better-scaled measure looks at degraded land relative to land that is currently used for agricultural purposes plus land that could be potentially brought into agricultural uses. This number is reported in the far-right column of table 8. Not all land is equally well suited for agriculture, so the number is a rough one. Still, it is clear that there are significant differences among countries as to how poor agricultural practices threaten agricultural productivity. In some countries, including Azerbaijan, Turkmenistan and Uzbekistan, degraded land area far exceeds the area that is currently suitable for agriculture.

Improved agronomy

As detailed in the IPCC report, the adoption of new technologies can provide direct and indirect mitigation benefits. For example, better agronomy and better resource management can result in greater accumulations of soil carbon. There are likely positive spillovers as well, or reverse leakages in mitigation parlance, that occur when individuals, motivated by better profits, adopt farming methods that boost land productivity. For example, using improved seeds and inputs are expected to slow or reverse the conversion of land from forests and pastures to cropland.

In general, this is what is currently happening in ECA. Since the early 1990s, productivity gains have been significant in many countries. Table 9 reports cereal grain yields in the region, and reports yields in Argentina, Canada, China, and Colombia for comparison. With the continued adoption of new seeds and farming practices, yields in the region have improved substantially and, for some countries, now rival yields found among the most advanced agricultural sectors. As with other aspects of the region, the gains have been uneven, with smaller increases in the Central Asian countries. Figure 11 reports the average percentage change in cereal yields and production based on three-year average yields centered on 1993 and 2008. Despite differences, the figure shows that yield gains exceeded production gains in most of the ECA countries. Only in the cases of Tajikistan and Turkmenistan has area expansion largely driven production growth.

As discussed later, a key determinant of yield growth and productivity growth in general is adaptive research that modifies crop characteristics to local conditions. Although this type of research is rarely motivated by climate policy, the spillover effects of research that leads to improved agronomy can be considerable for mitigation and for improving adaptation capacity.

Livestock grazing and waste

There are two primary links between climate change and livestock production. The first link has to do with how pasture lands are used. In cases where land property rights are weak and animal husbandry practices are poor, lands can be over grazed, leading to degradation, erosion and the depletion of the carbon stored in plants and the soil. Grazing animals are also a source of methane, a powerful greenhouse gas; however in well managed pastures; however, the manure from grazing animals adds organic material to soils, facilitating sequestration and partly offsetting the negative effects of released methane on the climate. In the last decades, the relationship between livestock production and land-use has changed significantly in the region. Figure 12 shows how land has shifted out of crop production and into pasture and grazing lands. This is consistent with improved production technologies that are land preserving discussed in the previous section. This has also been accompanied by a decline in livestock herd size – as measured in animal units. As an aside, animal units are a way of standardizing the environmental impact of animals on land. The coefficients adopted here are those used by state agencies in the United States, based on recommendations of the US environmental

protection agency.¹⁰ Overall, there has been a shift away from cattle and other larger animals to poultry production in the region (figure 13). Moreover, the trend is expected to continue. For example, poultry production is expected to grow by 50 percent in Russia by 2015 and pig meat production is expected to grow by 70 percent during the same period in the eight European Union members from Eastern Europe (Sutton et al., 2008). Figure 14 breaks down the change in livestock herd sizes by country.¹¹ In general, the shift places less pressure on grazing lands and creates greater opportunities for rotating crops and fallowing. The switch away from ruminants also promotes a more efficient conversion of feed and lower methane emissions from belching and flatulence.

The second link has to do with the commercialization of livestock production. In general, commercialized livestock operations rely more on feed lots, slaughter houses and other production methods that concentrate animals into smaller and more confined areas of land. The changing composition of livestock production in favor of pork and poultry operations reinforces this as well, since these animals are raised in more concentrated settings. Commercialized livestock production creates its own set of problems, for example it can lead to water contamination, overloaded soils and other problems; however the production methods also lend themselves more readily to methane capture, organic fertilization systems and biomass production, all of which create mitigation opportunities. Indeed, mitigation projects that improve the management of manure and other organic wastes are among the few types of agricultural projects financed under JI and the CDM.

IV. Policy instruments and mitigation outcomes

To this point, the discussion has focused on the sources of greenhouse gas emissions in ECA and opportunities to reduce net emissions at low cost. In this section, we turn to the sets of policies that give rise to mitigation outcomes. As the previous section on mitigation potential makes clear, greenhouse gas emissions in agriculture are closely tied to the choices farmers make about how they employ natural resources, especially land and water, decisions that are influenced by policies affecting agricultural markets and natural resource management. Increasingly, these decisions are affected by climate change and climate change policies as well. The relationships among climate change policy, agricultural policy and natural resource management policies are complex and varied, but the most visible change in the mix of policies has been the rise of policy-induced carbon markets that finance mitigation projects in agriculture and other sectors.

Looking ahead, what is striking is how current policies and the markets they engender are effective in tapping some sources of mitigation potential in agriculture but not others. Moreover, mitigation outcomes are only loosely tied to mitigation potential. This is partly because the methodologies used to build-up abatement cost curves that are used to quantify potential do not fully account for transaction costs – that is, the practical costs of moving from one type of technology use to another. In turn, there are significant differences in transaction costs among countries and across project types. Some differences have to do with national institutions and apply equally to all types of investments. Others are quite specific to the prevailing rules governing mitigation projects. Good policy can reduce transaction costs, but not eliminate them altogether, so fundamental differences in transaction costs will still affect mitigation outcomes. However it is also the case that design features of current institutions have practical implications for mitigation activities, especially in agriculture and, as a consequence, promote certain types of activities over others.

¹⁰ For more detail visit the Minnesota Department of Agriculture animal unit calculation worksheet, available on the Internet at <http://www.mda.state.mn.us/animals/feedlots/feedlot-dmt/feedlot-dmt-animal-units.aspx>.

¹¹ Data is reported in Annex 3.

Carbon markets and carbon market institutions¹²

The market for financial instruments tied to greenhouse gas emissions was valued at approximately \$US 142 billion in 2010, a market that arguably did not exist before the World Bank launched its Prototype Carbon Fund in 1999. A set of tradable instruments established under the Kyoto Protocol, and a set of instruments under a European cap that are also related to emission targets pledged under the Kyoto Protocol form the basis for most of the market.

Two project-based mechanisms, the Clean Development Mechanism and Joint Implementation, are important components of the first set of instruments. The programs were established under the Kyoto Protocol and created a framework for investments by government and private entities in mitigation projects in developing countries and transition economies. Additional rules set out in the Kyoto Protocol and subsequent agreements allowed offsets created under the mechanisms to be traded and used to meet treaty obligations. A subsequent agreement among European countries established a cap-and-trade program for GHG emissions, the European Union Emission Trading Scheme (EU ETS).

Setting explicit goals and using markets to achieve the goals efficiently are important components of the programs. It is the establishment of binding constraints on greenhouse gas emissions, either through treaty obligations or the setting of the cap, and the subsequent investments in mitigation projects that provide environmental benefits from both programs. In turn, secondary markets are important for price discovery and thereby provide incentives for undertaking cost-effective mitigation activities. Increasingly, carbon-market transactions involve the secondary market for EU ETS or CDM instruments. And it is trading in the secondary markets that has driven market growth overall from around \$US 11 billion in 2005 to nearly \$US 144 billion in 2009. For new projects, the CDM slice of the market is the largest; however the CDM's share of the market has declined from around 24 percent to just over 1 percent of the market in 2010 (figure 22).

The evolution of program rules

The JI, CDM and EU ETS institutions are all relevant for the ECA countries and all three programs have their origins in an evolving set of agreements under the United Nations Framework Convention for Climate Change (UNFCCC). The objective of stabilizing greenhouse gas concentration in the atmosphere to avert dangerous changes in the Earth's climate is set out in a portion of the UNFCCC that went into force in 1994. Meetings among treaty negotiators are known as Conferences of the Parties (COP). At the third COP, in Kyoto Japan, a set of additions to the UNFCCC, referred to as the Kyoto Protocol, laid out the framework for an international mechanism for reducing greenhouse gas emissions.

A guiding principle of the Kyoto Protocol is the notion of common but differentiated responsibility. Commonality comes from the physical property that greenhouse gases have a uniform effect on global warming independent of the source of emission; differentiation stems from the historical nature of current levels of accumulated long-lived anthropogenic greenhouse gases, which are primarily the consequence of emissions from developed countries. The cost of achieving emission reduction goals shaped the treaty as well, especially the notion of differing abatement costs.

Under current rules, the treaty sets out three levels of obligation among party participants. Over the first commitment period 2008 to 2012, industrialized countries, generally referred to as Annex I countries in reference to the annexed list in the Kyoto Protocol, are obligated to take specific steps to bring their overall carbon emissions below a 1990 baseline.¹³ Commitments are listed in Annex B of the Kyoto Protocol and

¹² This section relies on Larson et al. (2008).

¹³ The term is commonly used and inaccurate. The United States is listed in Annex I of the Protocol, but has not ratified the agreement. Belarus and Turkey are also listed but have withdrawn their offer to cap emission levels. Kazakhstan is listed in neither Annex I nor Annex B, but has pledged to limit emissions.

vary among the countries. By way of example, targets for the European Union and many transitional economies are set at 8 percent below 1990 levels, Russian targets are set at 1990 levels and Australian emission targets are 8 percent above 1990 levels. In addition, a wealthier subset of the Annex I countries, known as Annex II Parties, pledged to provide new and additional financial resources to facilitate and finance technology transfer and cover the costs of compliance incurred by developing country Parties.¹⁴ Developing countries, known as Non-Annex I Parties, are obliged to develop and periodically update their national inventories of greenhouse gas emissions by sources and removals by sinks, but are not committed to reduce emissions during the first commitment period.¹⁵

To complete some key definitions associated with the framework, the amount to which an Annex I Party must reduce its emissions over the commitment period is known as its “assigned amount.” These Parties are allocated “assigned amount units” (AAUs) up to the level of their assigned amount, corresponding to the quantity of greenhouse gases they can release in accordance with the Kyoto Protocol (Article 3), during the first commitment period. One AAU equals one ton of emissions, expressed as a carbon-equivalent (tCO₂e). Parties may offset their emissions by enhancing greenhouse gas sinks in the land use, land-use change and forestry (LULUCF) sector. Greenhouse gases removed from the atmosphere through eligible activities within this sector generate credits known as “removal units” (RMUs).

In addition to domestic actions, the Kyoto Protocol allows for three flexibility mechanisms intended to reduce the overall cost of the treaty. First, countries facing emission limits can purchase AAUs from other Annex B countries under the International Emission Trading provision (Article 17). In addition, as mentioned earlier, countries can invest directly in mitigation projects abroad. The Protocol distinguishes between, Joint Implementation, the framework for projects hosted in Annex B countries that have pledged to limit emissions, and the Clean Development Mechanism, the program for projects in and non-Annex I countries that have not pledged emission reductions.

Though conceptually similar, there are important practical differences in how the programs are administered and implemented. Offsets (credits) arising under JI are known as Emission Reduction Units (ERUs), while credits generated by CDM are known as Certified Emissions Reductions (CERs). Each CER and ERU represents one tCO₂e of greenhouse gas emission. All three Kyoto units (CERs, ERUs, and AAUs) can be traded and used to meet treaty obligations.¹⁶

Solving pollution problems through international cooperation had several precedents prior to Kyoto, but key aspects of the framework having to do with project credits were unique and have been controversial.¹⁷ To start, credits emanating from projects are based on a hypothetical baseline of emissions that would have occurred absent the CDM or JI investment. Judging an appropriate counter-factual is difficult at best and entails both economic and engineering challenges. As a practical consequence, the rules and procedures for approving and implementing CDM and JI projects have grown complex. In addition, CDM projects are expected to also advance development objectives. The criterion is loosely defined and judging whether it is met is difficult. Moreover, the twin objectives imply tradeoffs, since setting a high development objective for CDM projects can slow investment transfers and hamper the scope of the flexibility mechanisms to lower implementation costs. And finally, the flexibility mechanisms are expected to be supplemental to domestic

¹⁴ Current Annex II countries that have ratified the Protocol are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

¹⁵ Sinks are natural or man-made systems that absorb and store more greenhouse gases than they emit.

¹⁶ Only sovereign entities can trade AAUs, while both private and public entities can trade and own CERs and ERUs.

¹⁷ Examples of international cooperative action include the 1976 Convention Concerning the Protection of the Rhine River against Pollution by Chlorides and the 1985 Vienna Convention for the Protection of the Ozone Layer (Hanafi, 1998).

action and this has prompted debates about domestic policies governing the use of offsets. We return to these topics below.

As discussed, the Kyoto Protocol established two mechanisms by which countries facing emission limits to meet those obligations by investing in projects that reduce emissions elsewhere. Broadly, credits generated by CDM and JI projects are calculated by comparing the emissions or reductions from each project against a business-as-usual scenario, or baseline. Consequently, a significant portion of the project cycle entails developing arguments about why low-emission outcomes would not occur without investments associated with the project. Because this process is rule-based and because there are arguably incentives for both investor and host to exaggerate the environmental consequences of the project, the mechanisms were viewed with suspicion. Delegates and observers worried that weak controls and imprecise baselines might allow countries that had pledged reductions to purchase water-downed credits cheaply from developing countries, thereby attenuating the environmental benefits of the treaty and forestalling the development of new technologies. In addition, delegates from developing countries expressed concern that donor countries would meet emission reduction targets by redirecting existing aid flows to joint implementation projects (Ghosh and Puri, 1994; Parikh, 1995).¹⁸ One consequence was an extended period of rule making and details of the programs were left unfinished until the announcement of the Marrakesh Accords in 2001.¹⁹ The concerns also affected the design of the programs and have given rise to a specific set of national and international institutions that, in turn, shape private markets for carbon projects.

In particular, the final rules called for a centralized project-by-project review process and a conservative approach to validation. Less specific language in the treaty and in the implementation rules calls for projects to promote sustainable development and asks developed countries to ensure that Overseas Development Assistance (ODA) is not diverted to finance CDM projects. Language calling on countries not to depend too heavily on project-derived credits to meet treaty obligations, and specific rules limiting the use of credits from sinks reflects the qualified support given to the CDM by negotiators.

We return to these topics when we discuss how the rules governing projects affect decisions about investing in agricultural mitigation. Before doing so, we describe the process of creating projects under the twin Kyoto mechanisms and also discuss the markets that have grown up around them.

The CDM project cycle

In order to generate certified credits, projects located in developing countries must materially reduce or remove atmospheric greenhouse gas emissions and also contribute to sustainable development. In practice, most aspects of the CDM project cycles fall under the supervision of host national regulatory agencies – known as Designated National Agencies in UNFCCC parlance. And, in general, it is up to the host government to determine whether projects meet its sustainable development goals. This determination is part of the CDM project cycle and is signaled by a project-specific letter from the host country to the UNFCCC.²⁰

¹⁸ Lecocq and Ambrosi (2007) provide a good historical account of the CDM. Gulbrandsen and Andresen (2004) discuss the role played by nongovernmental organizations in this debate Grubb, Vrolijk and Brack (1999) provide a good account of the negotiations. See also criticisms in Cullet and Kameri-Mbote (1998). Chomitz (1999) discusses moral hazard problems relating to baselines.

¹⁹ Werksman (1998) gives an account of the CDM negotiations. den Elzen and de Moor (2002) discuss rules emerging from the Marrakesh Accords.

²⁰ Of course, additional criteria can be applied. For example, the Gold Standard Foundation requires additional stakeholder consultations for projects to qualify for its voluntary certification. In February 2008, the British government announced plans for a voluntary certification for CDM projects that conform to its Code of Best Practice for Carbon Offsetting. The Code is voluntary is administered by an Accreditation Board. The Code may be extended to Voluntary Emission Reductions soon (DEFRA 2008).

In contrast, the environmental integrity of a CDM project is subject to specific supervision rules and a series of checks along the project cycle by the UNFCCC Secretariat. To start, methodologies for establishing baselines must be approved on behalf of the UNFCCC by an international supervisory group, known as the CDM Executive Board. Approved methodologies are published and these can be drawn on by project developers. However, projects relying on new methods face the additional task of gaining approval. In either case, whether new or established methods are employed, developers must also convince the CDM board that their project methodology has been appropriately applied.

The project cycle also contains checks carried out by an independent firm or organization that has been accredited by a CDM Board. This entity, known as a Designated Operational Entity (DOE), initially validates the baseline design and the project's plan to monitor and measure outcomes.²¹ This occurs before the project is registered -- that is officially recognized by the CDM Board. For large CDM projects, a separate independent entity carries out the project's monitoring protocol, the process by which emissions or sequestrations are measured. The DOE is also responsible for certifying all emission reductions, although it is the CDM Board that issues and tracks the ownership all CERs. To boost the contribution of the CDM to sustainable development, a two percent levy on CERs goes toward an Adaptation Fund, designed to cover the CDM's administrative costs and to fund projects that help the poorest countries adapt to climate change.²²

The JI project cycle

Conceptually, Joint Implementation, the second project-based mechanism established by the Kyoto Protocol is less controversial since, because of an overall cap on allowed emissions from the JI host, any projects that abate greenhouse gases potentially lead to tradable units of carbon. Domestically financed projects do so by creating more headroom under the cap of allowed emissions, potentially contributing to a surplus that could be traded to other countries in the form of AAUs. The JI program provides an additional mechanism for foreign investment projects that directly create tradable carbon units in the form of ERUs. At the end of the Convention's accounting period, all types of carbon units are balanced, so the primary distinction between traded AAUs and traded ERUs has to do with how the underlying projects were financed.

Notionally, the practical hurdles of implementing JI projects are also lower. Since Annex I countries have pledged to cap domestic emissions, national guidelines used to measure emissions from wholly domestic projects can be applied to JI projects as well. Moreover, in contrast to the CDM project cycle, the JI program is designed to place full responsibility for the environmental integrity of the projects in the hands of hosting countries. In practical terms, Annex I countries that have the necessary national guidelines in place to track, measure and report emissions and reductions are able to issue and transfer ERUs without recourse to an international body for approval.²³

Many Annex I countries were late putting in place the domestic institutions needed to fully comply with UNFCCC JI eligibility rules.²⁴ And, rather than preclude projects in countries that have pledged emission ceilings while permitting them in countries that have not, the UNFCCC devised a second Track Two procedure for JI similar in structure to the CDM project cycles. Track Two projects are monitored by the Article 6 supervisory committee, also known as the Joint Implementation Supervisory Committee (JISC),

²¹ The overall design of the project is laid out in a Project Design Document (PDD).

²² The levy is not assessed against projects hosted by developing countries.

²³ To be eligible for participation in either project-based mechanism, Annex I countries: ratify the Kyoto Protocol; calculate their assigned amount; establish a national system for estimating emissions and removals; put in place a national registry to record and track the creation and movement of related tradable assets.

²⁴ As of May 2012, Track 1 projects had been implemented in Bulgaria, the Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Sweden, and the Ukraine.

which plays a role similar to the CDM Board. ERUs generated by track-two projects are measured against a baseline, whose methodology has been approved, as determined by an accredited independent entity (AIE) recognized by the JISC. In practice, several of the firms certified to validate CDM baselines (as DOEs) are also certified to validate Joint Implementation baselines (as AIEs).

EU Emissions Trading Scheme

The European Union's Emissions Trading Scheme (EU ETS) is one of the principal instruments that the EU relies on to meet its GHG emissions reduction requirements under the Protocol – an 8 percent reduction compared to 1990 levels by the first commitment period. Presently, the plan covers carbon dioxide emissions from more than 10,000 installations from the EU's 27 Member States plus, as of 2008, Norway, Iceland and Liechtenstein, members of the European Economic Area.²⁵ Together the installations account for about 40 percent of the EU's greenhouse gas emissions. Legislation that eventually launched the EU ETS in 2005 was approved by the European Council and the European Parliament in 2003.²⁶

To date, the policy has covered two periods. Phase 1 (2005-2007) of the cap-and-trade program was intended as a trial prior to the first commitment period of the Kyoto Protocol, which coincides with Phase 2 (2008-2012). Emission allowances, called EU allowances (EUAs), are permits equivalent to one ton of emitted carbon dioxide. During the first two phases, Member States allocated allowances to their regulated installation in accordance with a National Allocation Plan (NAP). At the end of each year, regulated installations must surrender allowances equivalent to their emissions. Surpluses and short-falls can be matched through sales and purchases.

Under current rules, NAPs are subject to European Commission oversight and the Commission can (and has) reduced the number of overall EUAs under national plans if the plans appear inconsistent with business-as-usual scenarios and climate change framework obligations. The back and forth between national planners and the Commission has generated delays and regulatory uncertainties.²⁷ Moreover, differences and inconsistencies in the process by which national governments allocated allowances created distortions and inefficiencies, which are discussed later in this section. Under a current proposal national plans would be abolished and replaced with an EU-wide cap based on harmonized rules. The proposal would also extend the system beyond 2012 and cover additional industries and two additional greenhouse gases, nitrous oxide and perfluorocarbons. Proposed rules would also allow Phase II EUAs to be carried forward into future periods.

The EU ETS allows firms to supplement their allocation of EUAs with credits from CDM or JI projects, although as discussed later there are restrictions that work against land-use projects. Moreover, although important, the EU ETS is not the only mechanism by which EU governments intend to meet their obligations under Kyoto. Still, the EU ETS cap provides the primary incentive for purely private sector engagements with JI and CDM projects.

The nexus of carbon market institutions and ECA

Table 10 shows how countries in the ECA region are distributed among the three regulatory settings. Ten countries are participants in the EU-ETS and also have pledged to reduce greenhouse gas emissions under the Kyoto Protocol by 6 to 8 percent. Four more remain outside of the EU ETS, but have committed to

²⁵ Currently, the sectors covered include energy activities (e.g. electric-power generation greater than 20 megawatts), ferrous metals industries (iron and steel), mineral industries (cement, glass, ceramics, oil refineries, etc.), and pulp and paper industries.

²⁶ For background information on the EU ETS see Watanabe and Robinson (2005), Convery and Redmond (2007) and Europa (2007).

²⁷ For example the Commission's review of Member NAPs required for the start of Phase II in January 2008, did not conclude until the fourth quarter of 2007.

reduce emissions (Croatia), or constrain them at base year levels (Kazakhstan, Russia and the Ukraine). Turkey's relationship within the UNFCCC has shifted over time. As part of the OECD, Turkey was originally listed in the Kyoto Protocol's Annex I and Annex II, but did not commit to emission reductions. Turkey became a party to the UNFCCC in 2004 and a party to the Kyoto Protocol in 2009. Turkey was removed from the Annex II list in 2007. Consequently, Turkey is an Annex I signatory of the Kyoto Protocol not included in Annex B.

Projects outcomes under Joint Implementation and the Clean Development Mechanism

As discussed, under current rules, the only formal way that developed countries can tap mitigation opportunities in developed countries and transition economies to meet their Kyoto commitments is through project-based mitigation efforts under Joint Implementation and the Clean Development Mechanism. This is especially important for agriculture since, according to IPCC, most low-cost mitigation opportunities are located in developing countries (recall table 6).

In the aggregate, the two project-based programs have successfully encouraged global investments in mitigation projects in developing countries and economies in transition. In fact, the CDM has exceeded projections made reported in the peer-reviewed literature before its launch (Rahman, Dinar and Larson, 2010). Still, analysis reported in Larson, Dinar and Aparis (2011) suggests that the CDM was able to tap less than 3 percent of the low-cost agricultural potential in developing countries identified by the IPCC. In this section, we look at project-based investments in the ECA region relative to the full set of global investments. We do so with the expectation that the programs, or alternative project-based programs, will continue in some form beyond 2012, which is the end of the first-commitment period under the Kyoto Protocol.

The first step in the analysis is settling on a definition of what constitutes an agricultural JI or CDM project. There is some confusion in reported studies since the classification systems used by the IPCC in the mitigation reports discussed earlier differ from how the United Nations Environment Programme Risoe Center on Energy, Climate and Sustainable Development (Risoe) reports projects in their widely used project data base.

Indeed as of July 1, 2011, there were no JI projects and only two active CDM projects classified by Risoe as agricultural.²⁸ This is superficial since many of the projects do relate to agriculture; however Risoe's classification choices are also indicative of the energy-sector focus of climate change policy discussions. Projects related to land use, the primary focus of the IPCC chapter on agriculture, are included under afforestation/reforestation projects, which we refer to as land-use-forestry projects.²⁹ Other projects related to agriculture – for example systems to manage animal wastes or projects that use agricultural waste products to generate energy -- fall into other aggregate categories in the Risoe classification system, such as biomass energy or methane avoidance; however, these groups include non-agricultural projects as well. Consequently, we are left to sort the projects in a way that better suits our purpose.

In this we follow the lead of the United Nations' Food and Agriculture Organization (FAO) and define an agricultural project as a project that uses agricultural residuals, outputs or agricultural processes to directly or indirectly reduce greenhouse gas emissions (FAO, 2010a). This definition is broad enough to include projects that sequester carbon in soils. We include projects that reduce methane emissions from composting agricultural waste products and also include waste water projects when the projects are linked to agricultural products – for example palm oil, cassava or distilleries. In general, the use of ethanol or biodiesel made from

²⁸ The two projects are, using Risoe project identification numbers, CDM6938 and POA0011.

²⁹ In UNFCCC parlance, the class of mitigation projects that sequester carbon in soils and forests are known as land use, land use change and forestry (LULUCF) projects, since the net mitigation comes from changing how land is used.

vegetable oils do not meet CDM additionality rules, although there are biodiesel projects under the JI. More common are projects in which residual agricultural organic matter is used to produce energy.

For the purpose of this paper, we focus on 6,961 CDM and JI projects that were active as of July 1, 2011. Of these, we classify about 19 percent as agricultural. Another 2.4 percent are forestry projects, and a category that includes agro-forestry projects. Taken together, these projects are expected to produce almost 3.3 million CERs and ERUs. The pipeline includes 1,304 agricultural projects that are expected to mitigate the equivalent of almost 250 million tons of carbon dioxide. Mitigation projects are highly concentrated in a handful of countries under the two Kyoto mechanisms. China, India and Brazil account for more than two-thirds of the projects overall and more than half of the agricultural projects (table 11). However, because of differences in the average scale of projects, the ranking changes when it is based on the expected mitigation impact of the projects – that is, the total offsets, CERs and ERUs, the projects are expected to produce by 2012. Measured in this way, Russia and the Ukraine are among the top five hosts, which together account for more than three-fourths of all expected offsets. Agricultural projects are also concentrated among a few hosts; China, India, Brazil and Malaysia account for 61 percent of the projects and 64 percent of agricultural offsets. Hungary and the Ukraine make appearances in the top twenty hosts, but represent small portions of the market overall. The make-up of the countries hosting forestry projects is somewhat different. Brazil, China and India are again leading hosts, as is Russia. However, within the small enclave of countries hosting forestry projects, other ECA countries, including Hungary, Moldova and Romania are significant.

As shown in table 12, there are 461 projects located in ECA countries, less than 7 percent of all projects worldwide. However, the projects are larger scale and account for 16 percent of the offsets expected by 2012. There are only 17 agricultural projects in the region and these are expected to generate just under 3,781 CERs and ERUs, accounting for about 1.5 percent of the mitigation impact of all agricultural projects. In comparison to countries outside the region, the portfolio of investments under the two mechanisms is more heavily weighted in projects that deal with industrial gases and with projects that aim to increase energy efficiency.

Table 13 shows the breakdown by country. Together, Russia and the Ukraine account for about 47 percent of the projects, but more than 77 percent of the expected offsets. The Czech Republic accounts for just fewer than 13 percent of the projects, but only about 1 percent of expected offsets. In part, the concentration of mitigation efforts in Russia and the Ukraine reflects the relative size of those economies and the opportunities for mitigation, but other factors are important as well. There are no projects in Turkey as a result of policy decisions already discussed. Other countries are eligible to host projects, but have had mixed success in attracting investments. Figure 16 reports on a rough relative measure of investment activity. The measure is constructed by taking the annual average tons of GHG mitigated by projects hosted by the country for the 2008-2012 period and dividing the average by GHG emissions in 1990, the reference year for most Kyoto commitments. By this measure, the two investment programs show considerable impact in several countries. The CDM countries of Armenia, Azerbaijan, Georgia, Macedonia, Moldova, Romania, and Uzbekistan have not pledged reductions; nevertheless, should planned projects come to full fruition, the projects would produce mitigation impacts ranging from 1 to 4 percent of their 1990 emissions. Expected offsets from projects in Bulgaria, Lithuania, Hungary and Russia, countries that have pledged to reduce or freeze emission levels, account for similarly scaled reductions.

At the same time, despite the significant scale of CDM and JI projects in some countries, the relative importance of project investment for the country's emission growth path is hard to gauge from the data. To start, there were no successful investment projects in 11 of the ECA countries. Moreover, the strength of project investment and eventual mitigation outcomes are not straightforward. For example, the total annualized flow of CERs expected from Azerbaijan's seven CDM projects are equivalent to roughly 4 percent

of total GHG emissions in 1990 and exceed the annualized 2.8 percent decline in emissions from 1990 to 2005, and the two rates were roughly matched in Lithuania and Russia. At the same time, the figure shows that overall GHG emissions fell just as fast rapidly in Latvia, Kyrgyzstan and Tajikistan, where there were no CDM or JI projects.

As mentioned, there are few agricultural or forestry projects in the region. In addition, there is little diversity in the types of projects. Of the 17 projects classified as agricultural, 9 of the projects are based on improving the management of manure from livestock operations. This group of projects includes two of the Hungarian projects, three of the projects hosted by the Ukraine, as well as projects in Armenia, Estonia, Poland and Serbia. The projects are mostly organized around hog or dairy operations. The remaining 8 projects have to do with converting agricultural residuals to energy, mostly the remains from sugar beet or sunflower operations. This list includes three sunflower projects in the Ukraine, two projects in Russia and projects in Bulgaria, Hungary and Moldova.

The range of forestry projects in the region is also quite limited. Of the 25 forestry projects in the region, 21 have to do with converting forest residuals, mostly from sawmill operations, into energy. This includes all eight projects in Russia, four projects each in Estonia and Hungary, and projects in Bulgaria, Macedonia, Romania, Serbia and the Ukraine.

Of the 461 active projects under the CDM and JI programs in ECA, only four projects were related to how land is used: two reforestation and afforestation projects in Moldova, and one project each in Albania and Romania. All four projects deal with the problem of restoring agricultural land that has been overgrazed or degraded by poor land management. All of the projects involve land that is publicly owned, either by the state or by local communities. Significantly, two of the projects are organized under the World Bank's first carbon financing fund, the Prototype Carbon Fund, while the remaining two projects operate under the World Bank's BioCarbon Fund.

Project markets outside the Kyoto mechanisms

Not all projects designed to mitigate greenhouse gas emissions from agriculture operate under the UN Framework. Voluntary markets offer an alternative way of financing agricultural land-use projects. Overall, these markets are small relative to regulated markets, including the CDM (recall figure 22). However, they are significant and collectively finance a greater volume of offsets than Joint Implementation.³⁰ Most voluntary market transactions originate in the United States, which is not a party to the Kyoto Protocol.³¹ Projects traded in voluntary markets are not subject to the same types of review and public disclosure that characterize the CDM market; however the application of third-party standards is common. In their annual review of voluntary markets, Hamilton et al. (2010) estimated that over 90 percent of voluntary transactions in 2008 and 2009 adhered to third-party standards, but also counted 18 competing standards active in voluntary markets. Still, some third-party standards are more frequently used. Among 676 voluntary projects surveyed by Peters-Stanley et al. (2011), 38 percent of the projects used Verified Carbon Standards, 19 percent use Climate, Community and Biodiversity Standards, and another 16 percent used Climate Action Reserve standards.³²

In some cases, the types of projects financed by voluntary markets are similar to classes of projects eligible for financing under the Kyoto mechanisms. For example, in 2009 landfill and wind projects accounted for 39

³⁰ Joint Implementation is a second project-based mechanisms established by the Kyoto Protocol for projects based in countries that have pledged reductions.

³¹ Hamilton et al. (2010) estimates that 56 percent of voluntary project transactions took place in the United States.

³² The Climate, Community and Biodiversity Standards are not used to quantify offsets; rather they are used to address sustainability and social impact.

percent of the offsets financed by voluntary markets (Hamilton et al., 2010). Still, investors have been attracted to the voluntary market as a way to invest in land-use projects that are difficult to finance or have been excluded from financing under the Kyoto mechanisms. For example, Peters-Stanley et al. (2011) report that 29 percent of the over-the-counter (OTC) transactions in 2010 involved so-called reducing-emissions-from-deforestation-and-forest-degradation (REDD) projects, most of which originated in Latin America. Another 11 percent were other forestry-based, while agricultural soils and livestock methane projects were the bases for another 3 percent and 2 percent of OTC projects.

The distribution of OTC project locations is heavily centered in North and South America, including 65 percent of all projects in 2011. This distribution is partly due to the fact that the US remains outside of the Kyoto Protocol and that REDD projects are outside the Kyoto mechanisms. In general, project developers appear to prefer projects under the CDM or JI programs where possible, although voluntary projects in China and India are on the rise. ECA countries remain outside voluntary markets, with the exception of Turkey (Peters-Stanley et al., 2011).

V. Hurdles to agricultural land-use projects under the Kyoto mechanisms

In the previous sections we documented the gap between the available mitigation opportunities in agricultural projects and capital flows into the region under CDM, JI and voluntary markets. In this section, we examine specific design features of agricultural projects and specific rules under the CDM and JI that work against land-use projects. We then explore how these also work to limit funding from markets outside of the Kyoto mechanisms.

Purposely, the twin Kyoto project programs are designed to facilitate capital flows to developing countries to tap low-cost mitigation opportunities and to promote sustainable development in developing and transition countries some of which have not themselves pledged emission reductions. But this basic design tenet of the mechanism has vocal critics and support for the mechanism, even among some signatories of the Kyoto Protocol, has been equivocal. One consequence is a set of varied national policies and a complex set of international implementation rules that try to remediate concerns about the environmental efficacy of the projects and their impact on development. Additionally and separate from the underlying questions that motivated their genesis, the mechanism's implementation rules give the CDM a particular institutional structure that has practical consequences, influencing the type of mitigation efforts feasible in developing countries within the UNFCCC. For the most part, this structure works against the development of projects related to how land is used and this, in turn, works to preclude the types of projects that would target the largest sources of low-cost mitigation opportunities within agricultural sectors. More generally, it also explains why the country and sector composition of the projects that now constitute the CDM project cycle pipeline differ from estimates of the sector-distribution of low-cost mitigation opportunities discussed earlier.

Objections to project mechanisms and their influence on its design

Although the JI and CDM programs were outlined in broad strokes in the 1997 Kyoto Protocol, the practical design of the mechanism was worked out in a protracted set of negotiations, which were not fully concluded until 2003. The rules that emerged partly reflected the early divergent views that had made negotiation over the mechanism so difficult. But they also reflected the difficult and technical challenges of designing and verifying project-based mitigation efforts when only one of the parties faces emission limits.³³

³³ The mechanics of project-based mitigation had been explored prior to Kyoto in a series of national pilot programs known collectively as Activities Implemented Jointly, with mixed results. See Larson and Breustedt (2007) and references therein.

Flexibility mechanisms

In the lead-up to the Kyoto Protocol, flexibility mechanisms were strongly opposed by several NGOs and some European negotiators, largely on normative grounds. For these groups, developed countries that contributed most to the accumulative of greenhouse gases over time were morally bound to redress the problem by acting within their own borders. Other groups went further, arguing that CDM would be exploitive and erode the authority of developing country governments.³⁴

The value of using offsets and other tradable permits to reduce the cost of mitigation was questioned on positive grounds as well, as some modeling work suggested that low carbon prices would reduce incentives for new innovative technologies and result in long-run welfare losses.³⁵ The basic logic of the argument is that investments made when carbon prices are high are more likely to be associated with innovative technologies that generate positive externalities that, in turn, improve the productivity of other firms. Said differently, advocates maintained that innovation increases as the shadow-price of capital devoted to mitigation increases – at least for a relevant set of carbon prices—and, over time, the benefits of improving the productivity of the mitigation function exceed the initially high costs of abatement.

In Kyoto, negotiators divided into separate camps and a coalition led by the EU and Swiss delegations pushed to place quantitative limits on the use of tradable credits. Language emerged in the final draft of the Protocol stating that the flexibility mechanisms would be “supplemental” to domestic actions, but, with the exception of forestry credits, quantitative restrictions were never imposed in subsequent rounds of rule making (Platjouw, 2009).³⁶ Nevertheless, national governments have leeway in how the flexibility mechanisms can be used within their borders, and several countries have imposed quantitative restrictions.

In the case of the European Emission Trading Scheme (EU-ETS), the aggregate use of Kyoto units is limited to 13.36 percent of the 2008-12 emission allocations; national rules vary. For example, Estonia forbids the use of Kyoto units, while Lithuania, Norway and Spain place a cap at 20 percent (Larson et al., 2008).³⁷ Moreover, in additions to general restrictions on CDM offsets, CERs originating from land- use projects are completely excluded from the EU-ETS, which has additional implications for pricing and finance, a topic that we return to latter.

Creating new credits

There was also great skepticism about project-based mitigation (Lecocq and Ambrosi, 2007). A core concern had to do with the idea of using a hypothetical business-as-usual counterfactual scenario to determine the number of credits earned by a particular project. As discussed, elements of the counterfactual cannot be observed and the full implications of the project are to a degree speculative, opening the evaluation process to strategic manipulation.

Conceptually, firms that face binding constraints under cap-and-trade or in the form of a carbon tax will undertake mitigation efforts to the degree that the costs are matched by the added revenue associated with additional emissions. Importantly, the firms make their own judgment about the efficacy of capital invested in mitigation. Outside of the cap, a different set of incentives are in place. Firms that fail to take mitigation efforts are not penalized, but can be induced to mitigate if it is profitable to do so. Indeed, this is the

³⁴ Harvey and Bush (1997) provide an early discussion of normative issues.

³⁵ Conceptual and numerical models suggest that this construct holds under special circumstances. Arguments related to the long-term benefits, via induced innovation, of restricting emission trading are discussed in Matschoss and Welsch (2006) and Weber and Neuhoff (2010).

³⁶ See in particular Articles 6, 12 and 17 of the Kyoto Protocol.

³⁷ Operating since 2005, the EU-ETS mandates an overall limit or cap on carbon emissions that originate from large industrial facilities and electric power generating plants and allows the trading of emission permits under the cap. The program affects firms in the EU's 27 member states, plus Iceland, Liechtenstein and Norway.

underlying essence of the CDM, since many low-cost mitigation opportunities are located in countries where greenhouse gas emissions are not regulated.

In this case, a judgment external to the firm must be made about how an investment affects emissions, and this leads to potential problems of information asymmetry. This is because firms both inside and outside of the cap stand to benefit from an exaggerated evaluation of an investment's impact since they can share a larger number of credits. A related difficulty is that new investments often affect emissions and production costs jointly. In this case, the private benefits from the investment (for example, from energy efficiency gains) must be subtracted from the cost of the investment used in the mitigation calculations. This becomes especially complex for projects where host firms face restricted access to capital, since the cost of capital enters into the calculation of economic additionality.³⁸

A final difficulty has to do with indirect "leakages," that is, when a portion of the mitigation gains from a project are lost via general equilibrium effects. This can occur when actions taken by firms in the aggregate influence the set of relevant input and output prices, inducing a change in the behavior of others. As a consequence, a set of unexaggerated mitigation claims can be over-valued in the aggregate when the business-as-usual baseline analysis is performed on a firm-by-firm basis. Burniaux and Martins (2000), Barker et al. (2007), and Larson et al. (2008) provide reviews of the literature.

Because of the incentives for firms to exaggerate their mitigation claims and the technical challenges of fully accounting for the secondary effects of project investments, negotiators decided that environmental additionality would be tested on a project-by-project basis, rather than at a program level as some negotiators had proposed.³⁹ Moreover, the review would be undertaken under the guidance of an independent Executive Board. This resulted in the current rules whereby the creation of credits requires both an initial approval of the baseline (counter-factual) methodology and monitoring methodology by the Executive Board, and a final certification of ex-post evidence that the mitigation had occurred.

The development objective and bilateral approval

As negotiations proceeded, there were several calls for a mechanism that would provide developing countries with a stream of revenue that could be used to promote mitigation activities. Most notable was the 1997 "Brazilian proposal," which envisioned penalties for countries that exceeded their pledged emission targets to be paid into a clean development fund to support mitigation efforts in non-Annex I countries (Matsuo, 2003). As the negotiations progressed, the idea of a central fund managed under the UNFCCC gave way to the notion that individual projects would likely benefit developing countries by improving access to capital and by fostering technology transfer. Consequently, it was left to host countries to determine on a case-by-case basis whether an individual project contributed to the host country's development objectives.⁴⁰

The decision resulted in a series of implementation protocols. For a project to go forward, project developers must obtain a letter of approval from the host country government stating that the proposed CDM project activity contributes to sustainable development. Project developers must seek approval from the investor

³⁸ These questions have to do with economic additionality, the situation where the mitigation benefits exceed the private benefits of the investment. In so-called win-win projects, this is not the case.

³⁹ Later rules were adopted to permit project developers to group coordinated action under in a single-project format, for both JI and CDM projects. The sets of actions, called a Program of Activities, usually involve small municipalities that coordinate mitigation efforts, for example, upgrading municipal waste facilities. A decision regarding the program was taken by the CDM Executive Board in June 2007. A similar program was established under JI in October 2009. See the UNFCCC website at <http://cdm.unfccc.int/ProgrammeOfActivities/index.html> and http://ji.unfccc.int/JI_PoA/index.html.

⁴⁰ Though separate from the CDM, special funds such provisions of the Global Environment Facility and the Clean Technology Fund have been established to assist mitigation efforts in developing countries.

country as well, although it is only the host country that makes a determination of the project's developmental impact. To make this practical, each country designates a responsible agency (known as the designated national authority) to formally certify the project's contribution.

Not all designated authorities are equally efficient, so country-specific differences in transaction costs emerge. Moreover, not all host countries were equally prompt in establishing a designated authority. Both factors have likely influenced the skewed geographic distribution of projects discussed earlier.

Although the potential for the CDM to promote technology transfers motivated the mechanism's late inclusion in the Kyoto Protocol, no formal mandate merged. Still, some project organizers claim to promote transfers in the documents they present to the Executive Board. Based on an examination of 854 early projects, Haites, Duan and Seres (2006) found that 81 percent of projects related to agriculture claim technology transfer. By way of comparison, only 41 percent of wind-energy projects and 15 percent of hydro projects in their sample claimed to have transferred technology.

Land management projects

Rule-making for sinks and land-use projects proved especially difficult. While most rules for the CDM were in place following conferences in Bonn and Marrakech in 2001, it was not until a final set of rule-making in 2003 that the full set of guidelines for Land Use, Land-Use Change and Forestry (LULUCF) projects emerged (Lecocq and Abrosi, 2007). The rules that did eventually emerge were cautious and restrictive, and placed strict limits on the creation of land-use credits, and special restrictions that distinguished land-use credits from the credits produced in other sectors.⁴¹

As discussed, land-use projects are technically complex since changes made to capture greenhouse gases can initially release carbon into the atmosphere. A full accounting of the type required for most CDM projects involves measuring the net change in carbon stocks for particular sites as well as any related increases in emissions off-site, taking into account above-on-and-below-ground biomass and soil organic carbon. The projects are also long-lived and subject to reversibility because of human activity such as logging or natural events such as forest fires or disease. Consequently, many negotiators held deep reservations about whether the projects would deliver sound and permanent environmental benefits. Added to this was a concern that CDM-market economics would favor projects based on fast-growing industrial plantations, crowding out projects that are community-based and that promote biodiversity (Hunt, 2008; Boyd, 2009).

In particular, current rules permit afforestation and reforestation projects but exclude projects designed to slow deforestation.⁴² Moreover, rules limit the total amount of land-use CERs that can be used to meet Kyoto obligations during the first commitment period to 5 percent of their base-year emissions; Bernoux et al. (2002) estimate that this limits the market for CDM land-use credits to 11 MtCO₂e for the first commitment period.

To address reversibility, a new set of credits was created with a special set of rules. To start, net removals from the project are certified every five years. Project developers can choose between two types of CERs: Long-term CERs (lCERs), which expire at the end of the project's crediting periods, or temporary CERs (tCERs) that expire at the end of the next commitment period. (For example, tCERs issued during the first commitment period would expire at the end of the second commitment period.) If the project performs as planned, new tCERs are issued to replace expiring ones until the end of the project's crediting period. However, Annex B countries that use tCERs during the first commitment period have to replace them during

⁴¹ The fact that rules for LULUCF projects came late penalized this class of projects as well, since it left less time for the project to generate offsets by 2012, the close of the first commitment period.

⁴² Reforestation is the restoration of depleted forests, while afforestation is the conversion of other lands to forestlands.

the next commitment period with so-called permanent credits (for example AAUs or CERs from non-LULUCF projects). The same restriction does not apply to the use of ICERs; however if the accumulated stocks of stored carbon from a projects for which ICERs have been issued declines during the five-year certifications, Annex-B countries must replace a proportional share of the ICERs that they used. If a project fails to submit a certification report, all ICERs issued to the project must be replaced.

Consequences for pricing and profitability

Built to redress weaknesses related to business-as-usual counterfactuals, features of the project cycles also influence a set of transaction costs that vary among types of projects. Because of this, the overall cost of operating a project can be high even when abatement costs are themselves low. This is the case for agricultural land-use projects, where the design of the CDM, the complex biochemistry of soil carbon sequestration and the frequent need to coordinate the activities of many land-users combine to inflate transactions costs. Moreover, many transaction costs are fixed and this works against small-scale projects in general, and smallholder and community-based projects in particular (Michaelowa et al., 2003; Skutsch, 2005).

Drawing on Dudek and Wiener (1996) and Cacho, Marshall and Milne (2005), Cahco and Lipper (2007) provide a topology of transaction costs for soil sequestration projects based on five categories: i) search and negotiation; ii) board approval; iii) project management; iv) monitoring and v) enforcement and insurance. Using this framework, the authors draw on published project reports for smallholder reforestation and afforestation projects to calculate project transaction costs by category. They find disparate results with wide differences among projects across all categories. They report search and negotiation costs ranging from US\$22,000 to \$160,000; and approval costs from \$12,000 to \$120,000. Differences in monitoring costs were remarkable, ranging from \$5,000 to \$270,000.⁴³

As discussed, the formal rules associated with implementing projects also work to limit demand. For example, in the case of CDM projects, limits on how CERs can be used under the EU ETS prevent full arbitrage between the markets and consequently CDM credits trade at a discount to their European counter-parts.⁴⁴ The restriction spills into formal markets for price discovery and risk management as well; for example, CERs originating from land-use projects are excluded from the European Climate Exchange. Rules that exclude projects from the CDM also shift some projects to voluntary markets where credits trade at a steep discount to credits traded under the European Union ETS (EU ETS) or the CDM. For example while all carbon prices fell dramatically in 2008 as global economic conditions worsened, spot prices for CDM offsets still remained above US\$15 tCO₂e for most of 2009. By comparison, the World Bank (2010a) estimates that the price for voluntary credits averaged less than US\$5 per ton.

In addition, market sentiment disfavoring land-use projects appears to extend beyond the effects of the formal rules. Outside of the CDM, this is revealed in the voluntary markets where offsets from land-use projects sell at a discount to other types of mitigation projects. In their review, Hamilton et al. (2010) noted that all of the over-the-counter agricultural soil credits they tracked originated on the Chicago Climate Exchange and, in line with that market, traded for an average price of US\$1.20 per ton; forest carbon offsets sold for just under US\$3 per ton and afforestation and reforestation credits sold for just over US\$4 per ton, on average.⁴⁵

⁴³ The authors found that enforcement and insurance costs were largely unreported.

⁴⁴ For example, the EUA-CER price spread ranged between 2-3 Euros during the first 9 months of 2010. (CDM Climate Research, 2010)

⁴⁵ As global economies slowed along with prospects for a US cap-and-trade, prices collapsed further and the Chicago Climate Exchange closed its doors in 2010.

Evidence of revealed preferences for particular types of projects can be found within formal CDM markets as well, even though all types of tradable Kyoto offset units are notionally equivalent for the purpose of meeting treaty obligations. For example, State and Trends of the Carbon Market (World Bank, 2010a) reports that owners of the most desirable renewable energy projects often by pass exchange platforms where no distinction made among CERs by origin in order to retain premiums of roughly 5 Euros per CER. A similar price differentiation occurs via the private branding of CDM projects, as land-use projects are frequently ineligible for some well-known third-party certification programs, including Gold Standard certification (Gold Standard Foundation, 2010).

Taken together, the restrictions land-use projects face during the CDM cycle, the formal restrictions placed on their use by governments, their disfavor among buyers, and higher transaction costs all work against the economic viability of land-use projects.

VI. The links between ancillary benefits and sustainable rural development

For many, the limited scope for agricultural land-use projects under the CDM represents a missed opportunity to finance sustainable development. This argument rests on two foundations. The first is the already discussed normative view that has to do with the sector composition of current investment flows. The notion here is that while the benefits of slowing climate change are especially important to the rural poor, the current composition of projects favor the energy sectors and manufacturing and consequently have little impact on this generation of the rural poor.⁴⁶ The second set of arguments, explored in the next section, has to do with the fundamental role played by soil carbon for agriculture, adaptation and soil fertility management.

Soil carbon sequestration and productivity

Numeric studies suggest that the ancillary productivity benefits of adopting carbon sequestering farming practices that come via higher yields are the dominant source of welfare gains for farmers working degraded soils. This ordering of benefits results from a confluence of factors, primarily assumptions about the price of agricultural outputs and inputs, the sequestration capacity of the soils, the price of carbon credits, and the costs of monitoring sequestered carbon. Using indicative numbers, Graff-Zivin and Lipper (2008) estimated that carbon-market related returns associated with switching from traditional to carbon-sequestering conservation methods ranged from US\$0.90 to \$15 per hectare, amounts that are unlikely to motivate changes in farming practices. To emphasize their point, the authors reference a study set in Senegal (FAO, 2004) that estimated the returns from marketable soil carbon credits amounted to less than four percent of household income. In contrast, productivity benefits are often large. This is illustrated in table 14. The table is constructed from a study by Tennigkeit et al. (2009) that looks at a stylized carbon sequestration problem for African maize on degraded soils under four farming practices. In all cases, the returns from improved yields exceed the gains from carbon credit sales.

Another way to measure the ancillary benefits of land restoration is to examine the rate of return on land restoration projects that do not include carbon financing. Sutton et al. (2008) give two examples from the region: the Anatolia watershed rehabilitation project in Turkey, and a project in Uzbekistan to reduce soil salinity. The project in Turkey combines a World Bank loan and a GEF grant to promote new farming and forestry production practices, to raise land productivity, and to reduce nutrient discharge from agricultural sources into the Black Sea and to strengthen related institutions for planning and resource management, especially community-based groups. The land management activities are likely to generate mitigation gains, but these benefits are not included when the project returns are calculated. Nonetheless, the economic return

⁴⁶ See, for example, Sirohi (2007) who looks at the composition of CDM investments in India.

to the project is estimated at 19 percent. The second project, in Uzbekistan, aims to restore soils by reducing salinity levels on about 100,000 hectares and expanding protective wetlands. Increases in soil carbon are likely to result from the project; however, the project still generates a 20 percent economic rate of return even when soil sequestration benefits are excluded.

It is also worth mentioning that carbon sequestration can be an ancillary benefit of research and extension efforts activities focused on other objectives. For example, the development of farming approaches that conserve soil moisture or soil nutrients can generate costs savings for farmers and deliver sequestration as well. Developing new high-yielding seeds that promote intensification can lead also to positive “leakages” when, in the aggregate, they reduce the conversion of forests to farmland. Moreover, though a sharp distinction is made between mitigation and adaptation under the UNFCCC framework, the distinctions blur in the case of land-use activities, since approaches that conserve soil nutrients or results in better soil moisture management also contribute to greater resilience in the face of climate change. This implies an important role for government-supported agricultural research that has resource management and sustainability objectives in mind. A recent World Bank (2010b) points to Brazil’s efforts in low fertility Cerrados areas as an example of sponsored research that jointly promotes productivity, adaptation and mitigation. However, even without accounting for positive co-benefits for mitigation and adaptation, the returns to agricultural research and extension are high. Sutton et al. (2008) note that rates of return for agricultural extension in the twelve countries of Eastern Europe, Caucasus and Central Asia ranged from 16 percent to an astounding 200 percent.

Carbon sequestration and other environmental services

Daily (1997), cited in Heal and Small (2002: 1347), provides a taxonomy for the types of benefits or services, that ecosystems provide. Most are closely associated with agriculture. Some are better measured than others and most of them are also interconnected.⁴⁷ Broadly, ecosystem services are divided into four different types (MEA 2005): i) provisioning services, mainly associated with production of food, fiber, fresh water, and hydropower; ii) regulating services, mainly associated with affecting environmental conditions that include flow regulation, recharge groundwater basins, water quality regulation, climate regulation, air quality, and carbon sequestration; iii) cultural services, mainly associated with recreation and ecotourism, aesthetic values, spiritual renewal, religious and cultural values; and supporting services, mainly associated with soil formation and fertility, photosynthesis, nutrient cycling and water cycling.

Because agriculture depends on ecosystem services, differences among farming practices have different consequences for related services. And in some instances, positive externalities associated with farming practices can be used to earn a premium based on consumer preferences – for example, “bird-friendly” coffee grown in a way that encourages biodiversity can command a higher price in niche markets. Even so, there are often disparities between what consumers are willing to pay and the notional values of the associated environmental service or the cost of providing it.⁴⁸ Efforts have been made to market carbon in a similar way and some third-party certifications focus on processes that safeguard the environmental integrity of the project credits. However, early evidence suggests that labels or certifications are of secondary importance for project credit pricing (Conte and Kotchen, 2009).

⁴⁷ The list includes: control of the vast majority of potential agricultural pests; cycling and movement of nutrients; detoxification and decomposition of wastes; dispersal of seeds; generation and preservation of soils and renewal of their fertility; maintenance of biodiversity; mitigation of droughts and floods; moderation of weather extremes and their impacts; pollination of crops and natural vegetation; protection from the sun's harmful ultraviolet rays; protection of coastal shores from erosion by waves; provision of aesthetic beauty and intellectual stimulation that lift the human spirit; purification of air and water; stabilization of the climate.

⁴⁸ See, for example, the discussion in Moon et al. (2002).

As Antle and Capalbo (2002) point out, many important phenomena in agriculture involve the behavior of complex systems whose behavior is affected by the interactions of two or more subsystems. In turn, because ecosystem services are interweaved, policies that address only one particular service or a subset of services may lead to distortive outcomes. Said in a different way, because agriculture is a complex and interactive system, creating an incentive mechanism that pays for only one stream of natural resource services may lead to perverse and unexpected outcomes when the payments affect other services adversely. In the particular context of carbon sequestration, the modification of management practices changes the overall economic profitability of their business as well as the level of externality impact on the natural system (Antle and Diagana, 2003; Pfaff et al. 2000). In some instances, the positive aspects of improving soil carbon complement other environmental services such as the provision of water resources. However, this is not guaranteed.

A generalization of the idea of paying for greenhouse gas mitigation is the idea of paying farmers or communities directly for undertaking a range of activities that safeguard environmental resources. For example, payments for environmental services (PES) have been used for protecting municipal water supplies in Colombia, Mexico, Ecuador and El Salvador (Pagiola, Arcenas and Platais, 2004). And in the case of Costa Rica, PES programs have been used to encourage carbon sequestration while simultaneously protecting watersheds, biodiversity and scenic beauty (Wunder, Engel and Pagiola, 2008).⁴⁹ The approach is attractive since conservation outcomes are rewarded directly. Moreover, it also provides a mechanism for harnessing revenue from dispersed beneficiaries to pay for local activities that generate positive externalities, which is itself an underlying motive for the CDM.

A case study of how carbon income incentives affect projects with multiple objectives is given by Nelson and de Jong (2003) and Lövbrand, Rindejäll and Nordqvist (2009); both papers discuss Scolel Té, a land-use agro-forestry sequestration project in Chiapas, Mexico established under a United States sponsored pilot project and part of the UNFCCC's Activities Implemented Jointly (AIJ) program.⁵⁰ The pilot featured a mix of community development and environmental objectives organized around a local trust fund (Fondo Bilclimatico), established in 1997 to broker carbon contracts between farmers and the voluntary carbon market. Under the AIJ, carbon credits were not eligible for credit against future greenhouse gas reduction commitments, but long-lived programs were eligible for conversion under the CDM once it was established. An effort was made in 2002 to assess the project's eligibility for conversion. Although the project currently remains outside of the CDM, Lövbrand, Rindejäll and Nordqvist (2009) argue that efforts to make the project viable under the CDM have resulted in a shift in emphasis away from the social and environmental objectives toward the provisioning of carbon sequestration.

As discussed, one of the hurdles with carbon sequestration projects has to do with the cost of coordinating actions among a large number of project participants. And one characteristic of PES systems is that they provide a shared mechanism for delivering payments for services. Shared organizational structures can be put to other uses as well. An example is Niger's Community Action plan, designed to organize local government to deliver services that promote development. In this case, the program promotes social protection, the build-up of local infrastructure, in addition to pilot soil conservation and afforestation projects (World Bank, 2010).

⁴⁹ See also a comparative analysis of PES systems by Wunder, Engel and Pagiola (2008) and a review of PES efforts in Brazil's Amazonia by Hall (2008).

⁵⁰ The AIJ program was a voluntary predecessor of the CDM, established as an umbrella framework for national voluntary mitigation pilot projects. See Larson and Breustedt (2009).

To date, most PES programs are located in Latin America and Africa, with few examples in ECA. The World Bank has invested in 14 PES projects, but none are located in ECA.⁵¹ And, while the theory of PES projects systems is straightforward, broad evidence as to their efficacy is limited (Pattanayak, et al., 2010). Still, several studies regional studies report many opportunities for land and water resource management programs that take advantage of PES systems, a portion of which could be financed by carbon offset payments. This is especially true in dryland areas and in places where soils are degraded (IFPRI, 2007; Thomas, 2008).

Blending PES and carbon markets

In this section we explore three land restoration and soil conservation projects hosted in ECA that blend features of PES systems with carbon financing and standard development project approaches long used by multilateral investment banks. The three projects are expected to lead to carbon sequestration while generating significant co-benefits, including improvements in agricultural productivity. As discussed, the sequestration of carbon through improved land management represents a large portion of low-cost mitigation potential globally. Moreover, land degradation is a pervasive problem in the ECA region, so there ample opportunity to replicate the projects described in this section. Even so, land restoration and soil conservation projects are rare among the CDM and JI projects.

The three projects are: the Assisted Natural Regeneration of Degraded Lands in Albania; the Moldova Soil Conservation Project; and the Moldova Community Forestry Development Project. The first two projects are registered under the CDM, while the Moldova Community Forestry Development project is in the CDM pipeline, but awaits registration (as of August 2011).

A core task of the Albanian project is to transform badly eroded lands into broadleaf forests of native species (World Bank, 2005, 2011a). The project is expected to benefit over 80,000 people in a variety of ways, including directly through the sale of project carbon credits, short-term and long-term (up to 20 years) employment, improved productivity, access to firewood and other forest products, cleaner water, reduced siltation in reservoirs, and protection from flooding and erosion. Broader public goods include an improved habitat for native flora and fauna and reduced sediment runoff to the Adriatic Sea. The challenges of coordinating stakeholders are significant, since 218 communes are involved in the project. Even so, the mitigation component of the Albanian project is relatively small. The project is expected to sequester 140,000 tCO₂e by 2012 and 250,000 tCO₂e by 2017. This is because the sequestration is measured on only 6,000 hectares managed by 30 communes, even though the project itself is expected to result in the better management of 660,000 of forest and pasture land. The expected project costs totaled \$US 19.4 million, made up of contributions by the Government of Albania, the Swedish International development cooperation Agency, the GEF, and the World Bank.

The Soil Conservation project in Moldova is expected to establish forests on nearly 15,000 hectares of degraded agricultural land on nearly 1,900 plots located in 151 local communities (World Bank, 2004 and 2011a). The project's main objective is to conserve and improve the productivity of agricultural soils by planting shrubs and trees, but the project is expected to generate other benefits, including access to fuel wood and other forestry products by household in nearby communities, and global biodiversity benefits. The project would also sequester 1.22 MtCO₂e by 2012 and 2.51 MtCO₂e by 2017. The project includes financing from a World Bank loan, and grants from the Government of Japan and funding from one of the Bank's carbon funds.

⁵¹For more, visit: <http://go.worldbank.org/51KUO12O50>. However, the GEF, which the Bank co-hosts with UNEP, has partially funded a project, managed by the World Wildlife Fund, that works with local communities in Bulgaria and Romania to protect the Danube watershed.

The second project in Moldova is largely a replication of the first project, which was viewed as highly successful by the Government of Moldova (World Bank, 2009 and 2011a). Again the main objective of the project is to provide protective forest belts in order to reduce erosions, landslides and thereby protect agricultural soils, but co-benefits from access to forestry products and restored habitats are expected as well. The project involves the coordination action of 264 local communities and is expected to sequester 229,000 tCO₂e by 2012 and 697,000 tCO₂e by 2017.

The projects have common features that the Kyoto project structure cannot easily accommodate. To start, the projects deal with reforestation, afforestation and soil sequestration which entail measurement hurdles. The credits that they produce are subject to special rules and face discrimination among eventual end-users. They all involve a large number of stakeholders. Moreover, because some of the land was abandoned or went unclaimed during land privatization, ownership remains with public entities, some of which have little capacity to adequately manage and monitor project activities and the disbursement of credit funds. Both the large number of participants and weak capacity of the governing entities add to transaction costs. At the same time, the projects generate significant direct and indirect benefits, even though these are hard to value. To make the projects work, the Governments of Albania and Moldova, together with the World Bank and other donors funded the projects primarily from non-carbon-market sources, using the relatively small flow of revenue from carbon sales as a source of supplemental funding or as a source of payments to communities as an incentive to pursue land management protocols.

VII. The potential for complementary climate change and resource management policies

To summarize from the previous sections, there is a consensus view that agriculture contributes significantly to flow of greenhouse gases emitted from Eastern Europe and Central Asia countries, although for most countries in the region emissions from the energy sector dwarf those from agriculture. Similarly, there is considerable potential for mitigation in the sector, especially at low costs. During the last decade, the international community has relied heavily on project-based investments to slow GHG emissions, primarily via the twin Kyoto project mechanisms, Joint Implementation and the Clean Development Mechanism. Both mechanisms are relevant for ECA and have successfully promoted investment flows in the region. With respect to agriculture, project-mitigation works well on a global scale for certain types of mitigation efforts in agriculture, mostly projects that manage organic wastes from livestock and agricultural processing, and projects that use agricultural by-products to produce energy. Land-use projects are less well suited to the project format and therefore subject to high transaction costs. This is due to the complex nature of carbon sequestration in soils and also the frequent need to coordinate actions across many households in areas where land institutions are weak. Moreover, current rules about creating land-use credits and using them work against soil carbon sequestration projects.

Evidence suggests that the gains from carbon sequestration, a global benefit, are small relative to local benefits to communities and agricultural households. Consequently, it makes little sense to organize land-use projects around carbon benefits per se. At the same time, what distinguishes carbon mitigation efforts from the provision of other ecosystem services from land and water resources is the availability of global markets and financing mechanisms for funding carbon mitigation services.

Taken altogether, this suggests countries in the region pursue separate but coordinated policies in which governments actively facilitate private-sector investment in mitigation projects to manage the region's growing need to manage methane and other emissions from livestock operations and agricultural processors, while also pursuing a policy that uses carbon financing to supplement natural resource management and the restoration of degraded lands. A key component of the first leg of the coordinated strategy is to promote a business environment that facilitates private investment, domestic or foreign, in mitigation projects. A key

component of the second strategy will be finding a comprehensive approach to landscape management that overcomes coordination problems and opportunistically takes advantage of carbon finance streams.

Promoting private project investment

Early on, negotiators of the Kyoto Protocol saw the two project-based mechanisms as a form of direct bilateral foreign investment, with firms or governments in countries with pledged commitments acquiring offsets by participating directly in projects hosted in developing countries under the CDM and transition countries under JI. As discussed in the section on new markets, alternative investment structures emerged. Often, companies and governments purchase shares of a pool of projects in order to better manage project risks and to avoid the direct costs of managing individual projects. In the case of large projects, funding frequently comes from multiple sources as well. Consequently, in a strictest sense, an “investing country” is the country responsible for certifying the conditions for a CDM or JI projects have been met, rather than the source of funding. In addition, there have been a number of so-called “unilateral” projects, where the project is organized and often financed by firms, governments or other entities in the host country. In the case of CDM projects, the investments are speculative, since the underlying CERs have no domestic use.

The pie charts in figures 17 and 18 show the sources of investment for the CDM and JI offsets expected from current projects by 2012.⁵² Globally, about 62 percent of project offsets are funded by financing flowing through the UK, Switzerland, Japan, or the Netherlands; another 15 percent of offsets come from unilateral projects. For ECA projects, unilateral projects account for about 27 percent of anticipated offsets. The Netherlands, the UK, Denmark, Japan and Switzerland account for another 56 percent.

It seems reasonable to think that both the general investment environment and the specific institutions related to carbon markets should influence the location of investments. However, in the case of ECA these relationships are hard to discern. For example, figure 19 reports on six key business environment indicators that are based on firm surveys. Two of the indicators reflect firm views about governance: whether the head of the firm thinks that the domestic court system is fair and impartial; and whether corruption is a problem for doing business. The remaining four indicators have to do with firm characteristics: whether any foreign investors have an ownership stake in the firm; whether a third-party certifies the quality of the goods or services produced by the firm; whether the firm has a line of credit available to it; and whether the firm reports a financial statement that has been audited by an outside accounting firm. The bars in the graph correspond to the percentage of surveyed firms that answer in the affirmative.

All things equal, direct foreign investment should be higher when governance is good and where firms have access to credit and where third parties verify the quality of their output and the veracity of their financial statements. The number of firms with foreign participation is an outcome, which hints at the overall climate for foreign investors. However, when averages are calculated over the countries that host investment projects and those that do not, it is difficult to distinguish between the two sets of averages. Nor is there a clear distinction between ECA and other regions.

The same is true when a measure of climate-related institutions is used. Figure 20 reports on the Climate Laws, Institutions and Measures (CLIM) index, “a comparative assessment of the extensiveness and quality of climate change mitigation legislation, policies, measures and institutions project investment under the CDM and JI programs” (EBRD 2011, p. 61).⁵³ The index is bounded between zero and one, with a higher value indicated an institutional environment more conducive to project investment. The figure ranks the ECA

⁵² In the case of multiple investing countries, the expected offsets were allocated equally among countries to facilitate calculations.

⁵³ For details about the index, see Teytelboym and Steves (forthcoming).

countries by the value of the index, separated into two groups. The upper portion of the figure (starting with the Czech Republic and ending with Azerbaijan) includes the countries that host projects, while the lower portion reports on countries do not. The countries with projects report a higher average score (0.35 versus 0.28), but there is considerably more variability within each group than there is between the groups.

One possible explanation why it is difficult to see a link between good institutions, which are expected to influence direct investment outcomes, is that private firms often take a back seat to governments and international organizations in the preparation of projects under JI and the CDM. Figure 21 reports on the participation of foreign investors in CDM and JI projects by region. For the purpose of the graph, projects were divided into three classifications. Keeping in mind that projects can have multiple investors, the three categories include: a) projects where the buyers are all private foreign firms; b) projects in which private firms did not participate; and c) partnership projects in which private firms purchased a portion of the credits and governments or multilateral public institutions, such as the World Bank, purchased the remaining shares. As the figure shows, about half of the projects were structured as foreign direct investments. Another 2 percent of the projects were partnerships. The remaining projects were structured as unilateral projects. The figure also shows that the investment structure in ECA is not so different from other sectors. Indeed, it is only in East Asia Pacific region where most projects are organized around foreign investors.

When the CDM and JI mechanisms were first introduced, proponents argued that the two programs would benefit developing and transitional economies in two ways: first, by providing an inflow of foreign capital and, second, by facilitating a transfer of technology. The prevalence of unilateral projects suggests that project organizers were often able to raise capital locally. However, it is hard to determine whether know-how accompanied the capital. In contrast, it is clear that foreign project investors brought considerable experience with them.

Table 15 reports on the 15 most frequently found investment structures in the region. Together, unilateral projects in the three countries at the top of the figure and the governments, multilateral agencies and private firms reported in the lower sections account for about 45 percent of the projects. As discussed, many of the regions' projects are unilateral and the figure indicates that many are in the Czech Republic, Russia and Lithuania. The Czech projects are mostly landfill projects with the participation of municipalities, while the projects in Russia and Lithuania are more varied. The Governments of Denmark, the Netherlands and Spain are all significant investors in ECA projects, as are the World Bank, the EBRD and the Nordic Climate Facility, a special investment program financed by the Nordic Development Fund. Among the private firms with significant presence in the region, Global Carbon, Camco, and Stichting Carbon Finance are all firms that specialize in carbon markets. Carbon-TF specialized in gas emissions from coal mine; the Mitsubishi Group is a large Japanese Conglomerate and Kommunalkredit is a government-owned Austrian infrastructure bank with a consulting subsidiary that manages CDM and JI projects.

The column to the far right of the table lists the number of projects outside of ECA that the listed investors participated in. What the table makes clear is that foreign investors bring with them experience from other regions. This is not necessarily the same as technical expertise of the type the two mechanisms were intended to promote, but it does suggest that foreign participation brings with it the potential of lessons learned through experience.

The same point is illustrated in a different way in figure 22. The graph shows the experience of project investors in ECA by type of investor. The underlying data is calculated by adding the number of projects that an investing firm, country or agency had participated in at the start of each CDM or JI project. In the case of a unilateral project, experience is determined by the number of previous unilateral projects in the host country. Private firms and public investors (countries and multilateral organizations) may have project

experience in regions other than ECA and the figure reports this type of experience as well.⁵⁴ The graph shows that private firms and public entities brought considerable experience from projects outside of the region when they invested in ECA. By the start of 2011, the average firm investing in ECA had participated in more than 25 projects outside of the region; investing public entities had, on average, invested in more than 35. Public institutions were also experienced with regional projects as well. At the same time, many of the private firms investing in ECA did not build up significant regional experience, while experience with unilateral projects in the region built over time.

Alternative financing for an integrated approach

As discussed earlier, PES systems can be organized to reward multiple objectives, such as the preservation of biodiversity or the safeguarding of water supplies, and several examples of comprehensive systems are given in an earlier section. In this sense, CDM, and JI projects can be viewed as a class of PES systems that pays for carbon mitigation, a particular type of environmental service. However, the funding of carbon mitigation projects is organized differently, since the Kyoto Protocol creates incentives for private payments. As discussed, for bio-energy and waste-management projects, there are few co-benefits beyond mitigation benefits and therefore the pricing mechanism is well suited. At the other extreme, activities and investments may generate mitigation benefits that are small in comparisons to environmental or poverty-reduction benefits and, as a practical matter, these can be ignored when policy instruments are designed. Still, evidence suggests that some agricultural land-use projects fall into an intermediate group with significant mitigation potential that also provide significant ancillary services whose financing is left to governments, international organizations and voluntary organizations. These sources are likely constrained, so, as a consequence, land-use projects will be under-funded even if the private sector adequately funds sequestration. Fortunately, there are old and new mechanisms that could be harnessed to better fund agricultural land-use projects, which we explore in this section.⁵⁵

The first has to do with innovations in carbon funds. While it is difficult to find examples of mechanisms that leverage carbon revenue streams to finance the full set of benefits from land-use projects, several funds pursue multiple objectives linked to conservation and the promotion of sustainable agriculture and development. Examples include the BioCarbon Fund, the Community Development Carbon Fund, both managed by the World Bank, and the World Wildlife Fund's conservation-carbon-finance projects.

In addition, multi-donor financing mechanisms have been established in recent years that can be used to supplement land-use mitigation activities. The largest and oldest is the Global Environmental Facility (GEF), a grant-making institution established in 1991 as a pilot project within the World Bank. The institution is now the financing instrument for the UNFCCC, as well as several other environmental conventions.⁵⁶ Though the GEF climate program is diffused across capacity building and adaptation programs, there is scope for mitigation activities and, in the case of agriculture, there is overlap with land management efforts designed to slow desertification that are also managed by the GEF.

⁵⁴ The European Bank for Reconstruction and Development, the World Bank, and the Nordic Climate Facility are the international organizations investing in ECA.

⁵⁵ One hurdle to any crediting of sequestered carbon is the issue of measurement. As discussed in the context of the Albania and Moldova CDM projects, there are approved CDM methodologies and toolkits available. Those three projects rely on two CDM methodologies, AR-AM002 and AR-AM003. More to the point, all parties to the UNFCCC provide an accounting of the net emissions inclusive of carbon sinks. In the case of the countries that have pledged emission reductions, this accounting has real effects since it helps determine the country's net emissions and consequently whether the country has a surplus or deficit of AAUs. Lokupitiya and Paustina (2006) review how carbon in agricultural soil is accounted for when national inventories are calculated.

⁵⁶ Included are the Convention on Biological Diversity, the Stockholm Convention on Persistent Organic Pollutants, and the UN Convention to Combat Desertification.

In 2008, two climate investment funds were established under UNFCCC auspices.⁵⁷ The Clean Technology Fund is designed to speed up the transfer and deployment of low-carbon technologies in order to slow greenhouse gas emissions. The programs are designed and implemented by countries with assistance from the Regional Development Banks and the World Bank Group. Fourteen country and regional plans were endorsed through 2010, funding US\$4.4 billion in programs. Potentially, the fund could be tapped to address land-use mitigation efforts, although that has not yet occurred (World Bank, 2010).

The second fund, the Strategic Climate Fund, funds programs in three areas relevant for agriculture. The first is the Forest Investment Program (FIP), which is intended to support developing countries efforts to stem deforestation and forest degradation. The program is also meant to build-up experience in anticipation of REDD (reduced emissions from deforestation and degradation). The program funds efforts to encourage alternatives to extensive agricultural practices that can drive deforestation. A second pilot program for climate resilience (PPCR) is meant to integrate adaptation efforts into development planning and implementation. However, the program has relevance to our discussion, because some adaptation activities also lead to mitigation outcomes. For example, the Niger program discussed above is partially financed by the PPCR (World Bank, 2010). The third window, Scaling up Renewable Energy (SREP), promotes renewable energy projects, including biomass energy pilots in rural areas.

Another potential source of financing is more recent. In the area of mitigation, COPs in Copenhagen and Cancun have focused on voluntary steps that developing countries can take to slow emissions or improve sinks, and on new vehicles to finance those mitigation efforts.⁵⁸ As part of that process, developing countries have been asked to submit a list of policies, programs and projects designed to mitigate domestic emissions, which are known as Nationally Appropriate Mitigation Actions (NAMAs). As of March 2012, 45 countries had signaled their intention to undertake domestic mitigation in some form.⁵⁹ In the context of NAMAs, agriculture is a natural area of focus for many of the countries because of the links between land-management, soil fertility and rural development. For example, in its NAMA, the Government of Ethiopia proposes projects that would add compost to agricultural lands and implement agro-forestry projects to improve rural livelihoods and sequester carbon in soils.

A related Green Climate Fund was introduced in Copenhagen and approved in Cancun that might provide direct funding to developing country governments for adaptation and mitigation efforts under NAMAs. Another idea, introduced by the Government of New Zealand, would be to finance NAMAs using tradable credits similar to CERs (Macey, 2009).

Among JI countries, there is also a potential to use revenues generated from the sale of AAUs to finance broader natural resource management schemes, including land restoration and soil conservation projects. The approach of pledging the proceeds from AAU sales for investments in environmental projects is often referred to as a “green investment scheme” (GIS). Doing so tends to boost the value of AAUs and counters the stigma associated with so-called “hot air” credits generated by the economic restructuring of transition economies. GIS programs are entirely voluntary and have been implemented in a number of ECA countries, including Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, Russia, Slovakia, and the Ukraine (Tuerk et al. 2010; Boyd and Salzman, 2011). Often, the schemes target areas not well suited for JI

⁵⁷ The funds operate as trust funds administered by the World Bank. CIF stakeholders include the Multilateral Development Banks, UN and UN agencies, Global Environment Facility (GEF), UN Framework Convention on Climate Change (UNFCCC), Adaptation Fund, Bilateral Development Agencies, Non-Governmental Organizations, Indigenous Peoples, Private Sector Entities, and Scientific and Technical Experts

⁵⁸ Each year, the UNFCCC holds a meeting of its members, known as a Conference of the Parties (COP).

⁵⁹ An updated list of NAMAs is available on the Internet at: www.unfccc.int/home/items/5265.php.

investments, especially improving building energy efficiency and forestry. For example, Bulgaria's GIS program emphasizes land-use.

VIII. Conclusions

The agricultural sectors of ECA offer abundant low-cost opportunities to slow the accumulation of anthropogenic greenhouse gases in the Earth's atmosphere. Moreover, in contrast to activities in other sectors, mitigation activities in agriculture often generate positive co-benefits rather than stark trade-offs between mitigation and economic growth. Still, most GHG emissions stem from how energy is created and used. As a consequence, the international treaties, domestic policies and the institutions that have grown up around them have been largely shaped by the sector and this, in turn, has influenced the mitigation policy instruments available to governments.

Of particular importance for mitigation efforts in the region are two project-based mechanisms under the UNFCCC, Joint Implementation and the Clean Development Mechanism. These programs can be leveraged by policy to provide a way for governments and private firms to invest in projects that reduce net emissions in other countries, including ECA countries, and thereby meet a portion of their Kyoto Protocol commitments. The twin mechanisms have been effective in driving investments in mitigation projects worldwide, including projects in agriculture sectors, but they are underutilized by many ECA countries.

Among the low-cost mitigation opportunities identified by researchers and reviewed in IPCC reports, are two broad classes of agricultural activities of comparable size: the first relates to how residuals and wastes from agricultural processes are managed and used as alternative sources of energy; the second includes land-use activities that sequester greenhouse gases in soils and plants. Projects of the first type are well suited to project-style interventions. This class of projects is a popular investment vehicle in countries outside of the region and there is significant scope for similar projects in the region if a project framework is extended post 2012. Moreover, this potential for this class of projects will likely grow as the commercialization of the region's livestock industry continues. Still, closing the gap between the region's significant mitigation potential and the currently limited rates of mitigation in agriculture will require tapping the mitigation potential tied to agricultural land, including agricultural land in ECA that has been abandoned.

For many reasons, land projects fit less well into project framework, and there are few successful land projects in JI or the CDM worldwide. For one, the sequestration processes can be reversed by future events, natural or man-made. Moreover, the bio-chemistry of soil sequestration is complex and place-dependent, making exact measurement difficult. Safeguards put in place intended to address reversibility and measurement difficulties add to the cost of implementing land-use projects, as does the frequent need to coordinate land-use activities across many stakeholders. Because of skepticism about the environment integrity of land-use projects, restrictions have been placed on how land-use credits can be used, undercutting demand. Moreover, even in voluntary markets where the effects of formal restrictions are indirect, buyers discount offsets from land-use projects. Taken together, these multiple factors encourage potential investors in offset projects to look elsewhere. What's more, activities taken to halt losses from already existing stores of carbon in soils or forests do not qualify for project-based support. This is especially significant in ECA, where large pools of carbon are stored above and below ground on unmanaged lands.

Potentially, current rules governing land-use mitigation and the preservation of carbon pools could be modified, an outcome that ECA countries can influence as Parties to the UNFCCC. One anticipated change is adding incentives to protect against increased emissions due to deforestation, under so-called REDD initiatives. These initiatives could be extended to protect soil carbon as well. Potentially, the rules governing UNFCCC land-use projects could also be modified to lower transaction costs. For example, the same methodologies countries use to calculate the net effects of land-use changes on carbon sinks for national

GHG inventories, which in turn influence the net demand for CDM credits, could be adapted to assess the benefits of land-use projects.

Even so, the task of managing land resources perhaps fits best within a cluster of national policies. This is especially the case in ECA, where large spans of degraded land, which create ancillary problems for water and soil resources, could be restored for productive use.

Agricultural policies, natural resource management policies and climate change policies are closely linked, and actions taken with the intent to influence outcomes in one domain often have consequences for the others, which is why a coordinated set of policies can be effective. In the case of good agricultural policy, activities pursued to promote sustainable growth can generate largely unintended mitigation benefits. For example, strengthen land markets can encourage land owners to better manage their cropland and pastureland for their own benefits, but with the consequence that soil- carbon is built up as well. Good natural resource management can work in the same way. For example, setting aside forests in order to preserve endangered plants and animals also prevents the release of carbon stored in the forest's plants and soils.

Even so, GHG mitigation efforts are unique, in that they are supported by carbon markets and incentives to invest in mitigation projects, a consequence of the Kyoto Protocol's flexibility mechanisms. This opens the door for using mitigation finance streams to supplement the costs of projects designed to deliver multiple public goods. Positive lessons on how to do this can be found in ECA countries, where public and private financing has been combined to restore degraded lands. National governments have the largest stake in managing their natural resources, but the global community benefits as well, since these activities promote biodiversity and reclaim land and water resources that sustain a global food system. Natural resource management plans, linked with good agricultural policy and national mitigation and adaptation plans, can help identify local and global needs and benefits and provide a framework for organizing and financing joint efforts.

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Table 1: Greenhouse gas emission by region, 1990 - 2005

	Emissions (GtCO ₂ e)				Per Capita Emissions (tCO ₂ e)			
	1990	1995	2000	2005	1990	1995	2000	2005
Australia & New Zealand	0.5	0.5	0.6	0.6	22.5	22.6	25.0	25.9
E. Europe & Central Asia	6.5	4.7	4.3	4.5	14.0	10.0	9.1	9.6
Latin America & Caribbean	2.1	2.3	2.8	3.0	4.8	4.9	5.3	5.4
Middle East & North Africa	1.2	1.5	1.7	2.2	4.4	4.9	5.2	5.9
South & SE Asia Pacific	6.6	8.3	9.1	12.3	2.4	2.8	2.8	3.6
Sub-Saharan Africa	1.4	1.5	1.6	1.8	2.8	2.5	2.4	2.4
US and Canada	6.6	6.9	7.5	7.7	23.6	23.4	24.0	23.3
Western Europe	4.2	4.1	4.1	4.2	11.1	10.8	10.6	10.6
World	30.0	31.1	33.2	37.8	5.7	5.5	5.5	5.8

Source: WRI (2011) and authors' calculations.

Table 2: Greenhouse gas emissions in ECA by gas and sector over time, 1990-2005

	Type of gas				Sector			
	CO ₂	CH ₄	N ₂ O	Other	Energy	Agriculture	Industry	Other
1990	4,890.0	1,212.2	384.3	37.2	5,530.7	623.7	173.6	195.7
1995	3,466.8	959.8	254.6	23.4	3,985.5	439.8	105.0	174.3
2000	3,230.8	824.4	230.8	25.0	3,673.5	364.6	105.7	167.2
2005	3,372.2	885.1	249.3	31.5	3,843.8	394.1	132.4	167.8
ECA's share of global emissions								
1990	0.23	0.21	0.13	0.16	0.25	0.12	0.17	0.15
1995	0.16	0.16	0.09	0.09	0.17	0.08	0.09	0.13
2000	0.14	0.14	0.07	0.07	0.15	0.06	0.08	0.12
2005	0.12	0.14	0.08	0.06	0.14	0.06	0.07	0.12

Note: all gases are expressed in MtCO₂e.

Table 3: Greenhouse gas emissions in ECA countries, 1990-2005

	1990	1995	2000	2005
	----- MtCo2e -----			
Russian Federation	2,932.1	2,086.3	1,905.8	1,954.6
Ukraine	941.9	590.1	465.9	493.9
Turkey	260.2	294.0	350.6	390.6
Poland	438.0	415.5	370.2	372.8
Kazakhstan	312.4	225.7	160.3	202.5
Uzbekistan	175.8	157.9	180.3	180.9
Czech Republic	186.9	148.2	143.7	141.8
Romania	240.1	163.7	123.7	131.6
Turkmenistan	71.1	54.9	64.1	91.4
Belarus	145.7	80.3	77.1	83.3
Hungary	100.0	81.7	79.3	82.5
Bulgaria	111.8	77.2	59.3	66.3
Serbia & Montenegro	87.7	58.6	56.6	57.9
Slovakia	71.1	51.9	47.6	50.1
Azerbaijan	83.0	46.6	54.9	47.8
Croatia	31.5	23.4	26.1	30.6
Slovenia	17.6	17.9	18.5	20.3
Bosnia & Herzegovina	32.4	6.2	18.8	19.8
Estonia	42.1	19.2	17.5	19.6
Lithuania	46.2	23.3	18.9	19.6
Moldova	38.7	16.8	10.8	12.5
Macedonia, FYR	12.1	11.1	11.3	11.8
Latvia	25.4	12.3	10.0	10.9
Tajikistan	21.2	11.2	9.5	9.9
Kyrgyzstan	29.4	8.5	8.4	9.7
Albania	9.1	4.5	6.5	9.1
Georgia	35.7	11.9	9.3	8.9
Armenia	24.5	5.7	6.0	7.4

Source: WRI (2011) and authors' calculations.

Table 4: Per capita greenhouse gas emissions in ECA by country, 1990 to 2005

	1990	1995	2000	2005
	----- tCo2e -----			
Turkmenistan	19.4	13.1	14.2	18.9
Estonia	26.8	13.4	12.8	14.5
Czech Republic	18.0	14.3	14.0	13.8
Russian Federation	19.8	14.1	13.0	13.7
Kazakhstan	19.1	14.3	10.8	13.4
Ukraine	18.2	11.5	9.5	10.5
Slovenia	8.8	9.0	9.3	10.1
Poland	11.5	10.8	9.6	9.8
Slovakia	13.5	9.7	8.8	9.3
Bulgaria	12.8	9.2	7.4	8.6
Belarus	14.3	7.9	7.7	8.5
Hungary	9.6	7.9	7.8	8.2
Serbia & Montenegro	11.6	7.6	7.5	7.8
Croatia	6.6	5.0	5.9	6.9
Uzbekistan	8.6	6.9	7.3	6.9
Romania	10.3	7.2	5.5	6.1
Macedonia, FYR	6.3	5.7	5.6	5.8
Azerbaijan	11.6	6.1	6.8	5.7
Lithuania	12.5	6.4	5.4	5.7
Turkey	4.6	4.8	5.3	5.5
Bosnia & Herzegovina	7.5	1.9	5.1	5.2
Latvia	9.5	4.9	4.2	4.7
Moldova	8.9	3.9	2.6	3.3
Albania	2.8	1.4	2.1	2.9
Armenia	6.9	1.8	2.0	2.4
Georgia	6.5	2.4	2.0	2.0
Kyrgyzstan	6.6	1.8	1.7	1.9
Tajikistan	4.0	1.9	1.5	1.5

Source: WRI (2011) and authors' calculations.

Table 5: Emissions by type of gas and by sector, 2005

Country	Emissions by type of gas				Energy MtCO2e	Emissions by sector		
	CO ₂	CH ₄	N ₂ O	Other gas		Agriculture	Industry	Other
Albania	4.8	2.9	1.3	0.1	4.6	3.4	0.3	0.8
Armenia	4.4	2.7	0.2	0.1	5.3	1.0	0.3	0.8
Azerbaijan	32.8	14.0	0.8	0.2	39.7	4.5	1.1	2.5
Belarus	62.3	13.7	6.9	0.4	64.0	13.1	2.3	3.9
Bosnia & Herzegovina	16.2	2.6	1.1	0	15.7	0.0	0.5	3.6
Bulgaria	46.8	10.3	8.7	0.5	50.6	6.6	3.9	5.2
Croatia	22.5	4.1	3.8	0.2	22.4	3.8	2.8	1.6
Czech Republic	121.7	10.5	8.1	1.5	126.9	7.7	4.6	2.6
Estonia	16.5	2.5	0.5	0.1	16.9	1.2	0.4	1.1
Georgia	4.1	3.5	1.2	0.1	4.6	2.3	0.5	1.5
Hungary	57.8	10.9	13.0	0.8	61.6	11.9	3.9	5.1
Kazakhstan	167.2	26.9	8.1	0.3	178.4	16.9	2.3	4.9
Kyrgyzstan	5.9	3.7	0.1	0.0	5.7	2.1	0.5	1.4
Latvia	7.7	1.9	1.0	0.3	8.1	1.5	0.4	0.9
Lithuania	13.9	3.9	1.4	0.4	14.5	2.2	1.3	1.6
Macedonia, FYR	9.2	2.0	0.5	0.1	9.1	0.7	0.4	1.6
Moldova	8.2	2.7	1.6	0.0	8.8	2.1	0.4	1.2
Poland	300.4	46.4	25.0	1.0	315.0	26.7	11.8	19.3
Romania	95.2	26.6	9.2	0.6	104.9	14.4	7.0	5.3
Russian Federation	1,562.6	314.5	57.5	20.0	1,744.8	117.8	45.0	47.0
Serbia & Montenegro	46.4	7.4	4.2	0	45.2	0	1.1	11.6
Slovakia	39.8	4.7	5.0	0.6	39.7	5.6	3.0	1.8
Slovenia	16.2	2.1	1.6	0.4	16.3	2.1	1.1	0.8
Tajikistan	5.8	3.0	0.4	0.7	5.8	2.4	0.9	0.8
Turkey	237.7	105.3	46.3	1.3	273.0	76.1	22.7	18.8
Turkmenistan	41.7	49.1	0.6	0.0	87.8	2.4	0.4	0.8
Ukraine	312.1	153.4	27.0	1.4	424.4	44.5	10.1	14.9
Uzbekistan	112.3	53.8	14.2	0.6	150.0	21.1	3.4	6.4

Source WRI (2011)

Table 6: Estimated greenhouse gas mitigation potential in 2030 by sector at or below \$20/tCO₂e.

	Total	Developing Countries
Agriculture	1.60	1.10
Forestry	1.25	1.05
Energy	1.90	0.80
Buildings	5.50	2.85
Transport	1.75	0.13
Other	1.50	0.97
Total	13.50	6.90

Note: potential given in Gt CO₂e per year. Mitigation from burning agricultural residue is attributed to sector in which the fuel-use takes place. The IPCC estimates that mitigation opportunities for this class of project at 1.26 Gt CO₂e per year. Source: Barker et al. (2007), Smith et al. (2007)

Table 7: Carbon stored in topsoils by land-use in ECA

Land use	Area (Km ²)	Min. Carbon (Mt)	Max. Carbon (Mt)
Low density grazing	2,179,504	3,043	7,863
Mixed agro-forestry	3,331,691	7,777	16,627
Moderate to high density crops and livestock	5,727,060	9,915	22,204
Unprotected virgin forest	5,368,165	14,535	30,730
Unmanaged	4,759,824	13,555	29,443
Other	2,348,108	6,497	13,811
Total	23,714,351	55,322	120,678

Source: FAO-UNESCO (2007); FAO 2010) and authors' calculations

Table 8: Estimated area of degraded lands in ECA as of 2000

Country	Degraded by agriculture	Degraded total area	Land suitable for agriculture
Albania	400	2,700	544
Armenia	300	300	241
Azerbaijan	4,700	4,900	2,434
Belarus	0	1,300	15,274
Bosnia & Herzegovina	0	5,100	1,922
Bulgaria	3,400	11,100	5,975
Croatia	300	5,600	2,934
Czech Republic	7,300	7,900	4,779
Estonia	0	200	1,997
Former Yugoslavia	2,000	12,000	4,605
Georgia	700	700	1,800
Hungary	2,700	6,000	6,929
Kazakhstan	3,500	47,300	3,107
Kyrgyzstan	400	400	414
Latvia	0	4,400	5,258
Lithuania	0	1,200	5,287
Macedonia, FYR	0	2,200	634
Moldova	0	3,400	2,219
Poland	4,600	26,000	22,296
Romania	11,000	23,700	12,238
Russian Federation	100,800	380,800	219,696
Slovenia	100	1,600	665
Tajikistan	900	1,000	1,219
Turkey	3,000	77,000	14,577
Turkmenistan	6,400	6,600	312
Ukraine	3,100	45,900	42,886
Uzbekistan	6,000	6,000	2,027
Total	161,600	685,300	382,269

Source FAO (2000). Note: Area is reported in thousand hectares

Table 9: Cereal yields in Argentina, Canada, China, Colombia and ECA, tons per hectare

	1992-1994	1997-1999	2007-2009
Argentina	2.91	3.45	3.82
Canada	2.57	2.82	3.22
China	4.48	4.91	5.44
Colombia	2.52	3.04	4.04
Albania	2.47	2.83	4.04
Armenia	1.66	1.65	2.42
Azerbaijan	1.79	1.78	2.67
Belarus	2.60	1.93	3.27
Bosnia and Herzegovina	3.56	3.59	4.06
Bulgaria	2.75	2.88	3.20
Croatia	4.12	4.77	5.77
Czech Republic	4.06	4.15	4.99
Estonia	1.69	1.62	2.85
Georgia	1.93	1.97	2.04
Hungary	3.57	4.68	4.62
Kazakhstan	1.06	0.91	1.20
Kyrgyzstan	2.35	2.45	2.64
Latvia	1.76	2.08	3.04
Lithuania	1.93	2.34	3.27
Republic of Moldova	2.98	2.88	2.17
Romania	2.44	3.10	2.57
Russian Federation	1.61	1.51	2.22
Serbia and Montenegro	3.10	4.05	4.14
Slovakia	4.04	4.10	4.35
Slovenia	4.02	5.54	5.35
Tajikistan	0.95	1.26	2.44
Macedonia, FYR	2.45	2.92	3.18
Turkey	2.10	2.19	2.56
Turkmenistan	2.38	1.87	2.89
Uzbekistan	1.68	2.28	4.34

Source: FAO (2011)

Table 10: Regulatory regimes in ECA

ECA Countries	Pledged Kyoto commitment for 2008-12 emissions (percentage of base year or period)	2008-2012 EU ETSs Cap (annual million EUAs)
Joint Implementation - EU ETS countries		
Bulgaria	-8	42.30
Czech Republic	-8	86.80
Estonia	-8	12.72
Hungary	-6	26.90
Latvia	-8	3.43
Lithuania	-8	8.80
Poland	-6	208.50
Romania	-8	75.90
Slovak Republic	-8	30.90
Slovenia	-8	8.30
Other Joint Implementation countries		
Croatia	-5	
Kazakhstan	0	
Russian Federation	0	
Ukraine	0	
CDM countries		
Albania		
Armenia		
Azerbaijan		
Belarus		
Bosnia & Herzegovina		
FYR Macedonia		
Georgia		
Kosovo		
Kyrgyz Republic		
Moldova		
Montenegro		
Serbia		
Tajikistan		
Turkmenistan		
Uzbekistan		
Annex I without Annex B commitments		
Turkey		

Source: UNFCCC and Europa (2007). Note: Kazakhstan declared its commitment to limit emissions in September 2009 (UNFCCC, FCCC/SBI/2010/6). Turkey became a party to the UNFCCC in 2004 and to the Kyoto Protocol in 2009 (Government of Turkey, 2011.)

Table 11: Host countries ranked by expected offsets from CDM and JI projects by 2012

All project types			Agricultural projects			Forestry projects			
Host country	Offsets (ktco2e)	Cumulative share	Host country	Offsets (ktco2e)	Cumulative share	Host country	Offsets (ktco2e)	Cumulative share	
Ranked by number of projects									
1	China	2,667	0.38	India	380	0.29	Brazil	22	0.13
2	India	1,663	0.62	China	156	0.41	India	16	0.23
3	Brazil	361	0.67	Brazil	136	0.52	China	15	0.32
4	Vietnam	188	0.70	Malaysia	117	0.61	Chile	13	0.40
5	Mexico	186	0.73	Mexico	110	0.69	Kenya	8	0.45
6	Malaysia	148	0.75	Thailand	103	0.77	Russia	8	0.49
7	Thailand	145	0.77	Indonesia	66	0.82	Uganda	7	0.54
8	Russia	134	0.79	Philippines	59	0.86	Colombia	6	0.57
9	Indonesia	124	0.81	Vietnam	30	0.89	Uruguay	5	0.60
10	South Korea	90	0.82	Honduras	10	0.89	Argentina	5	0.63
11	Philippines	87	0.83	Colombia	9	0.90	South Africa	5	0.66
12	Ukraine	83	0.84	Pakistan	8	0.91	Estonia	4	0.69
13	Chile	78	0.86	Chile	8	0.91	Malaysia	4	0.71
14	Colombia	74	0.87	Argentina	7	0.92	Hungary	4	0.73
15	Czech Republic	59	0.87	Ecuador	7	0.92	Indonesia	3	0.75
16	Peru	47	0.88	Kenya	6	0.93	Sri Lanka	3	0.77
17	South Africa	47	0.89	Ukraine	6	0.93	Congo DR	3	0.79
18	Argentina	38	0.89	Morocco	5	0.94	Vietnam	2	0.80
19	Bulgaria	38	0.90	Sri Lanka	5	0.94	Bolivia	2	0.81
20	Israel	32	0.90	Papua New Guinea	5	0.95	Paraguay	2	0.83
Ranked by number of expected offsets									
1	China	1,492,697	0.46	India	58,644	0.24	Brazil	20,630	0.38
2	India	420,178	0.58	China	44,067	0.41	Chile	3,939	0.45
3	Russia	301,960	0.68	Brazil	28,493	0.53	India	3,889	0.53
4	Brazil	170,665	0.73	Malaysia	26,695	0.64	Russia	3,638	0.59
5	Ukraine	111,704	0.76	Thailand	18,084	0.71	Colombia	3,227	0.65
6	South Korea	106,108	0.80	Mexico	17,925	0.78	China	3,068	0.71
7	Mexico	63,758	0.81	Indonesia	13,197	0.83	Hungary	2,902	0.76
8	Indonesia	37,390	0.83	Chile	6,990	0.86	South Africa	1,953	0.80
9	Nigeria	36,071	0.84	Philippines	5,561	0.88	Ghana	1,553	0.83
10	Chile	34,266	0.85	Colombia	4,019	0.90	Moldova	1,077	0.85
11	Malaysia	33,867	0.86	Vietnam	3,569	0.91	Congo DR	931	0.86
12	Argentina	30,422	0.87	Nicaragua	1,533	0.92	Romania	866	0.88
13	Vietnam	25,840	0.88	Honduras	1,242	0.93	Argentina	826	0.90
14	Thailand	24,326	0.88	Hungary	1,056	0.93	Uganda	818	0.91
15	South Africa	23,063	0.89	Ukraine	1,005	0.93	Bulgaria	586	0.92
16	Colombia	22,125	0.90	Nepal	1,004	0.94	Tanzania	481	0.93
17	Romania	20,875	0.90	Israel	997	0.94	Uruguay	443	0.94
18	Bulgaria	17,510	0.91	Ghana	921	0.95	South Korea	335	0.95
19	Poland	16,726	0.91	Ecuador	824	0.95	Kenya	304	0.95
20	Azerbaijan	16,545	0.92	Pakistan	816	0.95	Malaysia	271	0.96

Source: Risoe (2011) and authors' calculations

Table 12: Number of projects and expected mitigation impact by 2012

	ECA region		Rest of World	
	Number of projects	Expected mitigation (ktCO ₂ e)	Number of projects	Expected mitigation (ktCO ₂ e)
Agriculture	17	3,781	1,287	244,653
Alternative energy	41	11,398	1,635	347,016
Assorted gases	88	215,850	150	346,987
Biomass energy	13	5,423	34	7,177
Cement	4	2,593	51	34,331
Energy Efficiency	116	172,977	854	292,732
Forest	25	9,579	141	44,556
Fossil fuel switch	20	18,939	131	170,931
HFCs	5	14,202	24	478,199
Hydro	35	12,289	1,674	440,228
Landfill gas	78	18,086	349	203,778
Methane avoidance	19	50,163	131	116,434
Transport	0	0	39	10,342
Total	461	535,280	6,500	2,737,365

Note: The category for assorted gases includes non-agricultural projects designed to capture fugitive gases other than HFCs. Methane avoidance excludes projects to handle methane originating in landfills or agriculture.

Source: Risoe (2011) and authors' calculations

Table 13: Number of projects and expected mitigation impact by 2012 by ECA host country

Host country	Agriculture		Forestry		All Sectors	
	Number of projects	Expected mitigation (ktCO ₂ e)	Number of projects	Expected mitigation (ktCO ₂ e)	Number of projects	Expected mitigation (ktCO ₂ e)
Albania	0	0	1	161	3	215
Armenia	1	377	0	0	8	1,261
Azerbaijan	0	0	0	0	7	16,545
Belarus	0	0	0	0	0	0
Bosnia & Herzegovina	0	0	0	0	0	0
Bulgaria	1	56	1	586	38	17,510
Croatia	0	0	0	0	0	0
Czech Republic	0	0	0	0	59	6,111
Estonia	1	89	4	148	15	1,745
Georgia	0	0	0	0	5	2,398
Hungary	3	1,056	4	2,902	13	9,613
Kazakhstan	0	0	0	0	0	0
Kyrgyzstan	0	0	0	0	0	0
Latvia	0	0	0	0	0	0
Lithuania	0	0	0	0	16	8,150
Macedonia	0	0	1	0	5	1,859
Moldova	1	21	2	1,077	9	3,561
Poland	1	700	0	0	24	16,726
Romania	0	0	2	866	19	20,875
Russia	2	431	8	3,638	134	301,960
Serbia	1	47	1	26	6	990
Slovakia	0	0	0	0	1	63
Slovenia	0	0	0	0	0	0
Tajikistan	0	0	0	0	0	0
Turkey	0	0	0	0	0	0
Turkmenistan	0	0	0	0	0	0
Ukraine	6	1,005	1	176	83	111,704
Uzbekistan	0	0	0	0	16	13,994
Total	17	3,781	25	9,579	461	535,280

Source Risoe (2011) and authors' calculations

Table 14: Carbon soil sequestration and net revenue gain under alternative farming practices.

	No external inputs	Improved seeds	Improved seeds and fertilizer	Agroforestry
Carbon sequestration rate (tCO ₂ e)	0.5	1.0	1.5	4.0
Values (\$/ha)				
Annual carbon payments	\$1.15	\$4.90	\$8.65	\$27.40
Annual revenues from yield improvements	\$34	\$225	\$450	\$225
Total additional revenues	\$35	\$230	\$459	\$252
Seed costs	\$0	\$29	\$29	\$23
Fertilizer costs	\$0	\$0	\$60	\$0
Additional labor costs	\$45	\$68	\$90	\$75
Total additional costs	\$45	\$68	\$150	\$75
Net revenues	-\$10	\$162	\$309	\$177

Note: Carbon is priced at \$4.90 per ton CO₂e, maize at \$0.15/kg. Source: Tennigkeit et al. (2009).

Table 15: Most common investment structures in ECA

	Projects in ECA	Rank	Share of ECA projects	Projects in other regions
Unilateral projects in				
Czech Republic	46	1	8%	0
Russia	34	2	6%	0
Lithuania	8	15	1%	0
Investments by governments				
Denmark	32	3	5%	81
Netherlands	13	9	2%	23
Spain	10	12	2%	30
Multilateral investment banks				
World Bank	16	6	3%	86
European Bank for Reconstruction and Development	15	7	2%	2
Nordic Climate Facility	11	10	2%	16
Private firm participants				
Global Carbon	24	4	4%	1
Camco	23	5	4%	115
Kommunalkredit	14	8	2%	57
Carbon-TF	10	11	2%	1
Mitsubishi Group	10	13	2%	110
Stichting Carbon Finance	8	14	1%	1

Source: Risoe and authors' calculations.

Annex table 1: Original and reclassified land-use data for analysis

Original Landuse	Reclassified Landuse
Agriculture - large scale Irrigation	Mod. To high density crops and livestock
Agriculture - protected	Mod. To high density crops and livestock
Bare areas - protected	PAs with wetlands and forest
Bare areas - unmanaged	Unmanaged
Bare areas - with low livestock density	Low density grazing
Bare areas - with mod. livestock density	Mod. To high density crops and livestock
Crops and high livestock density	Mod. To high density crops and livestock
Crops and mod. intensive livestock density	Mod. To high density crops and livestock
Crops, large-scale irrig., mod. or higher livestock dens.	Mod. To high density crops and livestock
Forest - protected	PAs with wetlands and forest
Forest - virgin	Unprotected virgin forest
Forest - with agricultural activities	Mixed Agro-forestry
Forest - with moderate or higher livestock density	Mixed Agro-forestry
Grasslands - high livestock density	Mod. To high density crops and livestock
Grasslands - low livestock density	Low density grazing
Grasslands - moderate livestock density	Mod. To high density crops and livestock
Grasslands - protected	PAs with wetlands and forest
Grasslands - unmanaged	Unmanaged
No data	Other
Open Water - inland Fisheries	Other
Open Water - protected	Other
Open Water - unmanaged	Other
Rainfed crops (Subsistence/Commercial)	Mod. To high density crops and livestock
Shrubs - high livestock density	Mod. To high density crops and livestock
Shrubs - low livestock density	Low density grazing
Shrubs - moderate livestock density	Mod. To high density crops and livestock
Shrubs - protected	PAs with wetlands and forest
Shrubs - unmanaged	Unmanaged
Sparsely vegetated areas - mod.or high livestock dens.	Mod. To high density crops and livestock
Sparsely vegetated areas - protected	PAs with wetlands and forest
Sparsely vegetated areas - unmanaged	Unmanaged
Sparsely vegetated areas - with low livestock density	Low density grazing
Undefined	Other
Urban land	Other
Wetlands - protected	PAs with wetlands and forest
Wetlands - unmanaged	Unmanaged

Annex table 2: A range of carbon estimates by land use and country

Country	Land use	Area (Km ²)	Min. Carbon (MtC)	Max. Carbon (MtC)
Albania	Mixed Agro-forestry	4,641.4	4.9	13.2
Albania	Moderate to high density crops and livestock	21,714.6	26.1	65.3
Albania	Other	1,489.2	1.2	3.9
Albania	Unmanaged	319.7	0.4	0.9
Armenia	Low density grazing	131.5	0.2	0.5
Armenia	Mixed Agro-forestry	1,569.2	2.0	5.2
Armenia	Moderate to high density crops and livestock	23,877.8	43.4	95.4
Armenia	Other	1,637.0	2.6	5.5
Armenia	PAs with forests and wetlands	394.7	0.6	1.3
Armenia	Unmanaged	854.4	1.3	2.8
Azerbaijan	Low density grazing	783.5	0.6	2.0
Azerbaijan	Mixed Agro-forestry	3,646.7	5.0	12.2
Azerbaijan	Moderate to high density crops and livestock	68,269.7	71.0	202.7
Azerbaijan	Other	7,346.5	4.3	17.5
Azerbaijan	PAs with forests and wetlands	2,830.5	3.0	8.6
Azerbaijan	Unmanaged	2,874.9	2.5	7.6
Belarus	Low density grazing	5,094.6	10.0	20.1
Belarus	Mixed Agro-forestry	69,908.9	147.5	298.8
Belarus	Moderate to high density crops and livestock	117,042.7	250.9	510.3
Belarus	Other	8,080.6	17.9	36.4
Belarus	PAs with forests and wetlands	5,509.0	11.3	22.8
Belarus	Unmanaged	517.9	1.1	2.3
Belarus	Unprotected virgin forest	1,194.2	2.9	6.0
Bosnia and Herzegovina	Low density grazing	61.7	0.1	0.2
Bosnia and Herzegovina	Mixed Agro-forestry	19,619.2	43.5	92.7
Bosnia and Herzegovina	Moderate to high density crops and livestock	30,375.5	51.7	123.6
Bosnia and Herzegovina	Other	1,418.5	2.3	5.9
Bulgaria	Low density grazing	383.8	1.2	2.4
Bulgaria	Mixed Agro-forestry	34,493.0	60.0	127.2
Bulgaria	Moderate to high density crops and livestock	68,861.8	90.2	216.9
Bulgaria	Other	6,005.6	7.1	18.0
Bulgaria	PAs with forests and wetlands	256.7	0.7	1.4
Bulgaria	Unmanaged	381.8	0.8	1.6
Croatia	Low density grazing	373.5	0.0	0.7
Croatia	Mixed Agro-forestry	19,925.8	27.0	72.0
Croatia	Moderate to high density crops and livestock	27,944.9	26.2	84.3
Croatia	Other	6,707.6	4.6	18.5
Croatia	PAs with forests and wetlands	604.2	1.9	4.0
Croatia	Unmanaged	803.0	0.3	1.9
Cyprus	Mixed Agro-forestry	1,617.6	0.4	3.3
Cyprus	Moderate to high density crops and livestock	4,638.3	4.2	12.5
Cyprus	Other	2,880.8	2.2	7.3
Cyprus	Unmanaged	209.9	0.3	0.6
Czech Republic	Mixed Agro-forestry	22,378.0	54.4	114.2
Czech Republic	Moderate to high density crops and livestock	37,541.9	71.6	154.9
Czech Republic	Other	11,162.0	25.3	53.5
Czech Republic	PAs with forests and wetlands	7,587.2	23.3	48.7
Estonia	Low density grazing	1,130.4	4.0	8.3
Estonia	Mixed Agro-forestry	16,054.7	51.0	105.7
Estonia	Moderate to high density crops and livestock	18,975.7	64.1	133.3
Estonia	Other	5,390.2	16.7	34.5
Estonia	PAs with forests and wetlands	2,638.0	7.3	15.0
Estonia	Unmanaged	180.9	0.7	1.4

Source: FAO-Unesco (2007); FAO (2010) and authors' calculations

Annex table 2: A range of carbon estimates by land use and country (continued)

Country	Land use	Area (Km ²)	Min. Carbon (Mton)	Max. Carbon (Mton)
Georgia	Low density grazing	570.4	1.4	2.8
Georgia	Mixed Agro-forestry	24,034.2	46.4	98.2
Georgia	Moderate to high density crops and livestock	32,961.9	62.9	131.2
Georgia	Other	6,589.1	13.0	26.7
Georgia	PAs with forests and wetlands	1,081.2	3.1	6.4
Georgia	Unmanaged	4,115.6	12.6	26.3
Georgia	Unprotected virgin forest	689.8	1.8	3.7
Hungary	Mixed Agro-forestry	12,329.3	12.9	37.3
Hungary	Moderate to high density crops and livestock	67,174.2	122.8	276.0
Hungary	Other	11,345.4	22.9	49.9
Hungary	PAs with forests and wetlands	1,394.3	1.8	4.6
Hungary	Unmanaged	59.3	0.2	0.4
Kazakhstan	Low density grazing	1,228,062.5	974.7	3,251.7
Kazakhstan	Mixed Agro-forestry	21,970.7	43.0	98.0
Kazakhstan	Moderate to high density crops and livestock	936,615.0	1,480.9	3,383.7
Kazakhstan	Other	48,380.0	51.2	151.4
Kazakhstan	PAs with forests and wetlands	34,538.3	36.7	105.3
Kazakhstan	Unmanaged	383,576.1	108.1	812.0
Kazakhstan	Unprotected virgin forest	4,886.0	5.4	16.7
Kosovo	Mixed Agro-forestry	2,215.0	6.2	12.9
Kosovo	Moderate to high density crops and livestock	7,729.7	21.3	45.6
Kosovo	Other	697.1	0.7	2.2
Kyrgyz Republic	Low density grazing	41,138.8	63.2	137.3
Kyrgyz Republic	Mixed Agro-forestry	5,093.8	7.4	16.6
Kyrgyz Republic	Moderate to high density crops and livestock	98,370.5	120.5	300.2
Kyrgyz Republic	Other	3,710.4	5.6	13.4
Kyrgyz Republic	PAs with forests and wetlands	4,349.0	6.2	14.0
Kyrgyz Republic	Unmanaged	31,314.7	43.6	99.9
Latvia	Low density grazing	5,545.4	15.5	31.9
Latvia	Mixed Agro-forestry	23,142.4	65.2	134.2
Latvia	Moderate to high density crops and livestock	29,824.2	85.6	176.5
Latvia	Other	4,482.9	10.3	20.9
Latvia	PAs with forests and wetlands	1,079.0	2.3	4.6
Latvia	Unmanaged	94.2	0.3	0.5
Lithuania	Low density grazing	3,773.3	8.6	17.4
Lithuania	Mixed Agro-forestry	13,683.0	29.1	59.0
Lithuania	Moderate to high density crops and livestock	40,720.6	101.1	207.0
Lithuania	Other	5,695.9	13.7	28.0
Lithuania	PAs with forests and wetlands	646.4	1.2	2.3
Lithuania	Unmanaged	151.8	0.3	0.6
Lithuania	Unprotected virgin forest	243.1	0.4	0.9
Macedonia	Mixed Agro-forestry	7,595.4	18.8	38.8
Macedonia	Moderate to high density crops and livestock	14,200.5	28.6	63.9
Macedonia	Other	2,826.0	6.7	14.4
Macedonia	PAs with forests and wetlands	322.5	0.8	1.7
Macedonia	Unmanaged	64.7	0.1	0.2
Moldova	Mixed Agro-forestry	1,110.4	1.9	3.9
Moldova	Moderate to high density crops and livestock	29,957.1	49.8	106.0
Moldova	Other	2,514.5	4.1	8.6
Moldova	Unmanaged	58.7	0.1	0.2
Montenegro	Mixed Agro-forestry	4,352.6	7.8	17.1
Montenegro	Moderate to high density crops and livestock	7,571.6	11.0	26.6
Montenegro	Other	950.9	1.1	3.0
Montenegro	PAs with forests and wetlands	251.2	0.5	0.9

Source: FAO-Unesco (2007); FAO (2010) and authors' calculations

Annex table 2: A range of carbon estimates by land use and country (continued)

Country	Land use	Area (Km ²)	Min. Carbon (Mton)	Max. Carbon (Mton)
Poland	Low density grazing	1,841.8	2.5	6.2
Poland	Mixed Agro-forestry	71,879.0	122.3	263.7
Poland	Moderate to high density crops and livestock	204,767.7	307.1	721.1
Poland	Other	28,364.5	40.9	96.1
Poland	PAs with forests and wetlands	1,859.8	6.8	13.8
Poland	Unmanaged	2,382.0	8.0	16.7
Poland	Unprotected virgin forest	50.9	0.2	0.4
Romania	Mixed Agro-forestry	80,764.0	175.7	398.4
Romania	Moderate to high density crops and livestock	137,828.6	167.3	440.0
Romania	Other	15,578.5	18.9	50.7
Romania	PAs with forests and wetlands	2,127.6	1.1	5.2
Romania	Unmanaged	484.8	0.5	1.5
Russian Federation	Low density grazing	757,351.8	1,931.1	4,106.2
Russian Federation	Mixed Agro-forestry	2,650,110.9	6,391.2	13,659.0
Russian Federation	Moderate to high density crops and livestock	2,176,218.7	4,603.0	9,562.2
Russian Federation	Other	553,704.0	1,627.4	3,371.7
Russian Federation	PAs with forests and wetlands	1,368,227.8	4,241.5	8,885.4
Russian Federation	Unmanaged	3,853,842.4	13,325.1	27,548.6
Russian Federation	Unprotected virgin forest	5,360,983.0	14,524.2	30,702.3
Serbia	Mixed Agro-forestry	20,246.6	49.6	105.7
Serbia	Moderate to high density crops and livestock	51,412.2	125.7	273.0
Serbia	Other	6,139.4	15.0	33.0
Serbia	PAs with forests and wetlands	121.1	0.3	0.7
Slovak Republic	Low density grazing	169.7	0.3	0.6
Slovak Republic	Mixed Agro-forestry	16,596.4	35.3	75.8
Slovak Republic	Moderate to high density crops and livestock	18,212.3	32.2	71.3
Slovak Republic	Other	6,762.3	12.4	26.8
Slovak Republic	PAs with forests and wetlands	7,135.2	15.3	31.8
Slovenia	Mixed Agro-forestry	14,026.9	30.8	65.0
Slovenia	Moderate to high density crops and livestock	3,755.0	7.9	17.0
Slovenia	Other	2,743.6	7.3	15.4
Tajikistan	Low density grazing	20,074.9	8.2	45.4
Tajikistan	Mixed Agro-forestry	804.8	0.1	1.6
Tajikistan	Moderate to high density crops and livestock	58,529.7	44.5	172.0
Tajikistan	Other	4,199.0	5.1	15.8
Tajikistan	PAs with forests and wetlands	4,284.1	1.0	9.1
Tajikistan	Unmanaged	44,518.1	20.5	102.9
Turkey	Low density grazing	13,198.9	13.7	37.5
Turkey	Mixed Agro-forestry	99,232.7	186.3	383.1
Turkey	Moderate to high density crops and livestock	599,129.3	666.6	1,777.2
Turkey	Other	52,587.4	66.3	166.8
Turkey	PAs with forests and wetlands	67.3	0.0	0.1
Turkey	Unmanaged	9,875.5	13.1	32.9
Turkmenistan	Low density grazing	51,152.2	3.7	98.0
Turkmenistan	Moderate to high density crops and livestock	140,128.9	39.7	322.1
Turkmenistan	Other	11,696.1	11.2	40.7
Turkmenistan	PAs with forests and wetlands	11,550.9	0.0	20.8
Turkmenistan	Unmanaged	253,682.6	0.5	457.5
Ukraine	Low density grazing	53.1	0.1	0.2
Ukraine	Mixed Agro-forestry	68,583.3	151.7	313.7
Ukraine	Moderate to high density crops and livestock	479,443.1	914.9	1,849.0
Ukraine	Other	34,861.6	63.1	128.2
Ukraine	PAs with forests and wetlands	4,431.9	10.6	22.4
Ukraine	Unmanaged	4,526.1	7.4	15.8
Ukraine	Unprotected virgin forest	117.7	0.1	0.3
Uzbekistan	Low density grazing	48,612.1	3.6	93.7
Uzbekistan	Mixed Agro-forestry	64.8	0.0	0.1
Uzbekistan	Moderate to high density crops and livestock	173,266.3	222.5	683.7
Uzbekistan	Other	21,161.9	34.5	97.6
Uzbekistan	PAs with forests and wetlands	7,711.5	4.4	18.3
Uzbekistan	Unmanaged	164,935.1	7.1	307.3

Source: FAO-Unesco (2007); FAO (2010) and authors' calculations.

Annex table 3: Number of cattle, chickens, pigs and sheep in ECA countries, 1995, 2000, 2005 and 2009

Country	Cattle ('000)				Chickens ('000)			
	1995	2000	2005	2009	1995	2000	2005	2009
Albania	840	728	655	494	2,624	4,087	4,671	5,138
Armenia	504	479	573	585	2,700	4,100	4,590	3,950
Azerbaijan	1,341	1,664	2,007	2,281	13,600	14,200	17,500	21,450
Belarus	5,403	4,326	3,963	4,131	29,900	26,400	23,500	29,200
Bosnia & Herzegovina	403	462	460	458	3,700	9,000	9,540	17,260
Bulgaria	638	682	672	565	17,822	13,300	17,159	15,765
Croatia	493	427	471	447	10,724	10,351	7,267	6,707
Czech Republic	2,030	1,574	1,397	1,349	25,522	13,658	14,322	24,042
Estonia	420	267	250	238	3,130	2,414	2,161	1,757
Georgia	944	1,122	1,145	1,028	7,346	8,000	9,300	6,200
Hungary	910	857	723	701	33,906	25,890	32,814	31,165
Kazakhstan	8,073	3,998	5,204	5,992	32,450	17,880	25,530	30,000
Kyrgyzstan	920	932	1,035	1,225	1,978	2,659	4,121	4,000
Latvia	551	378	371	380	3,700	3,100	3,450	4,000
Lithuania	1,152	898	792	771	8,650	6,226	8,227	8,841
Macedonia, FYR	281	270	248	253	4,880	3,350	2,617	2,172
Moldova	832	423	331	218	14,362	12,535	17,420	18,220
Poland	7,306	6,083	5,483	5,700	46,395	49,526	134,424	124,129
Romania	3,481	3,051	2,808	2,684	70,157	69,143	87,014	84,373
Russian Federation	43,296	28,032	22,988	21,038	483,200	339,000	328,707	366,282
Serbia & Montenegro	1,950	1,427	1,196	1,163	23,491	18,948	14,816	17,116
Slovakia	916	664	540	484	7,322	6,080	13,262	13,249
Slovenia	477	471	451	470	5,415	4,256	3,114	4,387
Tajikistan	1,199	1,037	1,303	1,800	1,473	770	2,296	3,682
Turkey	11,901	11,054	10,069	10,860	183,684	239,748	296,876	244,280
Turkmenistan	1,181	1,400	2,025	2,154	4,000	5,500	10,000	14,570
Ukraine	19,624	10,627	6,903	5,079	136,000	118,000	131,976	158,800
Uzbekistan	5,484	5,268	6,571	8,025	18,000	14,407	20,540	29,100

Source: FAO (2011)

Annex table 3 (continued): Number of cattle, chickens, pigs and sheep in ECA countries, 1995, 2000, 2005 and 2009 (continued)

Country	Pigs ('000)				Sheep ('000)			
	1995	2000	2005	2009	1995	2000	2005	2009
Albania	100	103	147	160	2,480	1,939	1,760	1,768
Armenia	82	71	89	85	623	506	557	527
Azerbaijan	33	20	23	10	4,373	5,280	6,887	7,685
Belarus	4,005	3,566	3,407	3,704	230	92	59	53
Bosnia & Herzegovina	400	450	653	529	490	584	903	1,055
Bulgaria	1,986	1,512	931	784	3,398	2,549	1,693	1,475
Croatia	1,175	1,233	1,205	1,250	453	529	796	619
Czech Republic	3,867	3,688	2,877	1,909	134	90	148	197
Estonia	460	286	340	365	62	28	38	78
Georgia	367	411	484	86	754	553	689	690
Hungary	4,356	5,335	4,059	3,383	947	934	1,397	1,236
Kazakhstan	1,983	984	1,292	1,347	24,273	8,725	11,519	14,126
Kyrgyzstan	118	105	83	63	4,924	3,264	2,965	3,606
Latvia	501	394	436	384	86	29	39	67
Lithuania	1,260	936	1,073	897	40	14	22	48
Macedonia, FYR	172	226	156	194	2,466	1,289	1,244	455
Moldova	1,061	683	398	284	1,411	930	823	762
Poland	20,418	17,122	18,112	14,279	713	362	316	286
Romania	7,758	5,848	6,495	6,174	10,897	8,121	7,425	8,882
Russian Federation	24,859	18,271	13,413	16,162	31,818	12,603	15,494	19,602
Serbia & Montenegro	4,192	4,087	3,177	3,604	2,671	1,917	1,837	1,814
Slovakia	2,037	1,562	1,149	741	397	337	321	362
Slovenia	571	558	534	432	29	73	119	139
Tajikistan	33	1	1	0	1,958	1,472	1,782	2,579
Turkey	8	3	4	2	35,646	30,256	25,201	23,975
Turkmenistan	128	35	30	30	6,100	7,500	13,089	13,513
Ukraine	13,946	10,073	6,466	6,526	4,793	1,060	875	1,096
Uzbekistan	350	80	87	92	9,053	8,000	9,555	11,405

Source: FAO (2011)

Figure 1: Emissions by sector, 2005

Source: WRI (2011) and authors' calculations.

Figure 2: Emissions by type of gas, 2005

Source: WRI (2011) and authors' calculations.

Figure 3: Agricultural GDP, agricultural emissions from methane and nitrous oxide, 2005

Source: WRI (2011) and World Bank (2011).

Figure 4: Change in share of emissions by type of gas between 1990 and 2005.

Source: WRI (2011) and authors' calculations.

Figure 5: Change in share of emissions by sector between 1990 and 2005.

Source: WRI (2011) and authors' calculations.

Figure 6: Mitigation potential by agricultural practice.

Source: Smith et al. (2007)

Figure 7: Mitigation potential in agriculture by region.

Source: Smith et al. (2007).

Figure 8: Low cost annual abatement potential by 2030 in Turkey

Source: McKinsey (2009) reported in EBRD (2011)

Figure 9: Low cost marginal abatement potential in Russia

Source: McKinsey (2009) reported in EBRD (2011)

Figure 10: Land degraded by human activity.

Source: FAO (2000)

Figure 11 Change in production and yield of cereal grains from 1993 to 2007

Source: FAO (2011)

Figure 12: Livestock and changing land use in ECA

Source FAO (2011)

Figure 13: Changing composition of livestock in ECA

Source: FAO (2011) and authors' calculations.

Figure 14: Changing composition of livestock in ECA by country.

Source: FAO (2011)

Figure 15: Carbon markets, 2005-2010.

Source State and Trends of the Carbon Market 2011 (World Bank, 2011)

Figure 16: Project offsets as annualized reductions from 1990 emissions and average emission reduction

Note: Project reduction represent average annual offsets expected from CDM and JI projects from 2008 to 2012 as percentage share of 1990 GHG emissions.

Figure 17: Sources of investor financing, all CDM and JI projects

Source: Risoe (2011) and authors’ calculations.

Figure 18: Sources of investor financing, CDM and JI projects in ECA

Source: Risoe (2011) and authors’ calculations.

Figure 19: Indicators of general business environment

The table draws on enterprise surveys in Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kosovo, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, the Russian Federation, Serbia, Slovak Republic, Slovenia, Tajikistan, and the Ukraine. (World Bank 2011)

Figure 20: Measure of climate policy environment

Source: Teytelboym and Steves (forthcoming)

Figure 21: Investment structure by region.

Source: Risoe (2011) and authors' calculations.

Figure 22: Average project experience at start of new project by types of investors.

Notes: Average project experience shows the number of projects in regions other than ECA, or within ECA for the public sector and for private firms in the indicated year.

Map 1 : Organic carbon content of topsoils in East Europe & Central Asia (FAO-UN, 2007)

Source: Carbon pool (FAO 2007)

DECCT 2011

Map 2 : Select land use types in Eastern Europe and Central Asia (FAO 2010)

Source: Land use (FAO 2010)

DECCT 2011

Map 3 : Net Primary Production loss from 1983-2003 (FAO, 2008)

Source: Land degradation (FAO 2008)