How Has Environment Mattered?

An Analysis of World Bank Resource Allocation*

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Executive Summary

How has environment mattered for the World Bank? The aggregate figures suggest that it has mattered a great deal, since the Bank's total environmental lending has exceeded $US 9 billion over the past six years. In this paper, we use newly-available data to address a more precise version of the question: Across countries and themes, how well have the Bank's environmental lending and Analytical and Advisory Activities (AAA) matched the incidence of environmental problems? For our assessment, we extend our previous work on local pollution and fragile lands (Buys, et. al., 2003) to consideration of global emissions, biodiversity, water resources and institutional development. We construct cross-country problem indicators for each environmental theme, and combine them with country risk measures to estimate optimal thematic lending and AAA for each country. Then we compare our estimates with actual lending and AAA to assess the match between environmental problems and the Bank's response.

We begin by constructing an overall indicator of environmental problems from our thematic indicators. Using regression analysis, we find a strong relationship between countries’ general indicator values and the scale of their environmental borrowing, but a relatively weak relationship for AAA. At the thematic level, we find that problem indicators have relatively weak relationships with both lending and AAA. Adding country risk to the analysis, we test an optimal allocation model and find that it is consistent with the Bank’s actual lending and AAA since 1998. We conclude that our model’s assignment of lending and AAA to countries reflects the Bank’s actual experience with partner countries. The model’s explanatory power is relatively low, however, and when we compare model assignments to actual allocations, we find many large discrepancies for countries and environmental themes. Some gaps may reflect activity by other donor institutions, but many others may represent problems with efficient implementation of the Bank’s Environment Strategy. To promote further discussion of this issue, we use our optimal allocation model to develop measures of lending opportunity by environmental theme for the Bank's partner countries.
1. Introduction

The World Bank has become the world's largest source of financing for environmental improvement in developing countries. During the period 1998 - 2003, the Bank lent approximately $US 9.2 billion for environmental purposes in 381 projects.1 The scale of this activity indicates that environment has mattered a great deal to the Bank and its partner countries. Until recently, however, data scarcity has prevented a more detailed assessment of the Bank's environmental operations. In this paper, we use newly-available information to ask how, more precisely, environment has mattered: Across countries and themes, how well has the Bank's allocation of resources for lending and Analytical and Advisory Activities (AAA) matched the incidence of environmental problems? The analysis extends our previous work on local pollution and fragile lands (Buys, et al., 2003) to consideration of global emissions, biodiversity, water resources and institutional development. We construct a cross-country problem indicator for each environmental theme, and assess the match between thematic resource allocation and problem incidence. To assist in promoting a closer match, we also combine our environmental indicators with information on country risk to estimate optimal resource allocation across countries.

The remainder of the paper is organized as follows. Section 2 introduces our environmental indicators, and Section 3 provides a measure of country risk. Section 4 describes the Bank's environmental accounting information. In Section 5, we assess the match between country lending and the general scale of countries' environmental problems. Section 6 extends the analysis to thematic lending. Section 7 introduces our

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1 This estimate by the Bank's Environment Department includes environmental components of loans in other sectors (e.g., transport, agriculture), as well as loans that are attributed to the environment sector.
optimal allocation model, with a brief review of the methodology developed in Buys, et al. (2003). Assuming continuity with the past scale and thematic composition of lending, Section 8 uses the model to estimate lending and AAA opportunities by country and environmental theme for the period 2004-2009. Section 9 interprets our findings using two country cases, and Section 10 provides a summary and conclusions.

2. Environmental Indicators

Building on prior work by Buys, et al. (2003), we construct country indicators for six environmental problems: greenhouse gas emissions; health damage from air and water pollution; the threat of natural resource degradation on fragile lands; threats to biodiversity; problems related to water resources; and problems with environmental policies and institutions. All of our indices reflect recent research on the cross-country incidence of environmental problems.

For global greenhouse gas emissions, our indicator is total metric tons of carbon-equivalent in 2000 from fuel combustion (CO2), land-use change (CO2) and other sources (methane (CH4), nitrous oxide (N20), hydrofluorocarbons (HFC’s), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6)). We draw our emissions estimates from the World Resources Institute’s Climate Analysis and Indicators database. Our estimate of pollution damage is total DALY (disability-adjusted life year) losses from air and water pollution. We draw our DALY estimates from recent research.

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3 The World Resources Institute’s Climate Analysis and Indicators database is available online at http://cait.wri.org.
For natural resource degradation, we base our indicator on recent research that identifies the vulnerability of people on fragile lands (i.e., land that is steeply-sloped, arid, or covered by natural forest) as a major determinant of rural poverty and natural resource degradation in developing countries (World Bank, 2003). Our indicator, the total rural population living on fragile lands, has been constructed from a GIS (Geographic Information System) - based spatial overlay of demographic, topographical, climatic and natural resource information.

We have developed our biodiversity threat indicator from a variety of sources. For terrestrial biodiversity, we use a GIS-based spatial overlay of human population with critical areas identified by Conservation International (CI), the World Wildlife Fund (WWF), and Birdlife International (BI). We also include freshwater lake areas, to capture the role of inland aquatic ecosystems. The World Bank’s Environment Strategy focuses on both the threat to biodiversity from human encroachment, and the value of biodiversity resources for human populations. Our indicator for this two-way relationship in each country is its total human population in critical biodiversity areas. For marine biodiversity, we draw on estimates of reef ecosystems at risk by Bryant, et al. (1998). Summing across all endangered reefs, we use each country's share of the total as our index of marine biodiversity threat. While terrestrial and marine threats are quite distinct geographically, we create a composite indicator to match the Bank's thematic category (biodiversity conservation). Since the two indices are weakly correlated ($\rho = .27$), assignment of relative weights has a significant impact on the result. We assign equal weights, because we have no scientific basis for a differentiated weighting scheme.
To construct a water-resource indicator, we draw on two sources of information. The first is an estimated geographic distribution of excess demand for water resources (surface and sub-surface) in Vörösmarty, et al. (2000). We use GIS to compute the total population residing in excess-demand areas identified by this research. The second information source is a database of deaths and injuries from floods maintained by the Centre for Research on the Epidemiology of Disasters (CRED, Université Catholique de Louvain). For each of the Bank's partner countries, we calculate the sum of deaths and injuries for all recorded floods since 1960. In constructing an indicator for flood damage, we weight deaths to injuries in the ratio 50:1. Using equal weights, we combine our indicators for demand pressure and floods into a composite indicator of water-related problems.4

We derive our indicator for environmental policy and institutional problems from two sources. The first is the World Bank's Country Policy and Institutional Assessment (CPIA) database, which rates environmental policies and institutions on a numerical scale of 1 (the lowest) to 6. For this exercise, we reverse the scaling (1 becomes the highest) and normalize the ratings so that countries with the greatest problems score 100. To proxy the scale of the problems confronted by environmental institutions, we compute the mean value of our five thematic indicators (global emissions, pollution, natural resource degradation, biodiversity threats, water-related problems).5,6 To assure equal weighting

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4 Our index of demand pressure also provides a useful proxy for economic damage from drought conditions. We are indebted to our colleagues in the Bank’s Middle East / North Africa region for this observation.
5 While the CPIA ratings provide useful information for comparing institutional needs, they are not sufficient for judging investment priorities because they do not account for differences in the scale of environmental problems faced by a country's institutions. If Brazil and Bhutan receive the same CPIA rating, for example, ignoring their scale difference will lead to assignment of identical lending in the optimization model.
6 We recognize that an equal-weighted index is only one of numerous plausible indicators for general environmental problems. In Appendix 2, we develop alternative indices and analyze their association with
with the institutional rating, we normalize this mean indicator to the range [0 - 100]. Our composite indicator is the product of the normalized environmental index and CPIA rating.

Table 2.1 illustrates the calculation of the policies and institutions indicator for four countries in Sub-Saharan Africa. This indicator (row 8) equals the product of the indicator of institutional development problems (row 7) and the indicator of overall environmental problems (row 6). The latter is the average of problem indicator values for global emissions, pollution, fragile lands, biodiversity and water resources. The four country cases illustrate the contributions of separate components to the final indicator values. Chad has a low overall environmental indicator (.69) but a very high institutional indicator (5), yielding a product of 3.44. South Africa’s overall environmental indicator (4.24) is about six times Chad’s value, but its institutional indicator (2) is much lower because its institutions are more highly-developed. The resulting composite indicator for South Africa (8.49) is about 2.5 times Chad’s indicator value (3.44). Kenya has about the same composite indicator value as South Africa (8.35), but the indicator components are quite different. Kenya’s environmental indicator (2.39) is somewhat more than half of South Africa’s (4.24), but Kenya’s institutional problem indicator (3.5) is about 1.8 times South Africa’s. As a result, the products of the two indicators are nearly the same for the two countries. Of the four countries, Nigeria has by far the largest composite indicator value (25.29) because of the size of its overall environmental indicator (8.43).
### Table 2.1 Environmental Policies and Institutions Indicators for Four African Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Chad</th>
<th>Kenya</th>
<th>South Africa</th>
<th>Nigeria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Global Emissions</td>
<td>0.45</td>
<td>1.35</td>
<td>8.43</td>
<td>7.26</td>
</tr>
<tr>
<td>2 Pollution</td>
<td>1.09</td>
<td>1.89</td>
<td>1.14</td>
<td>12.92</td>
</tr>
<tr>
<td>3 Fragile Lands</td>
<td>0.94</td>
<td>3.27</td>
<td>4.60</td>
<td>12.52</td>
</tr>
<tr>
<td>4 Biodiversity</td>
<td>0.53</td>
<td>4.15</td>
<td>2.90</td>
<td>6.67</td>
</tr>
<tr>
<td>5 Water Resources</td>
<td>0.44</td>
<td>1.27</td>
<td>4.15</td>
<td>2.77</td>
</tr>
<tr>
<td>6 Overall Environmental Indicator</td>
<td>0.69</td>
<td>2.39</td>
<td>4.24</td>
<td>8.43</td>
</tr>
<tr>
<td>7 Institutional Development Problems</td>
<td>5.00</td>
<td>3.50</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>8 Environmental Policies and Institutions Indicator</td>
<td>3.44</td>
<td>8.35</td>
<td>8.49</td>
<td>25.29</td>
</tr>
</tbody>
</table>

### 3. Country Experience with Project Implementation

The World Bank lends to countries that have highly-varied experiences with implementation. To incorporate this factor, we draw on a database maintained by the World Bank's Operations Evaluation Department (OED). The database rates the outcomes of 3,075 World Bank projects implemented in 146 countries since 1990. OED rates projects in eight categories: highly satisfactory, satisfactory, moderately satisfactory, marginally satisfactory, marginally unsatisfactory, moderately unsatisfactory, unsatisfactory, and highly unsatisfactory. We interpret the highest two ratings as "successful" for our purposes, and define our country risk indicator as the percentage of projects rated successful by OED. Table 3.1 displays the distribution of our results by region. Although the estimated success rates are generally highest in Eastern Europe/Central Asia and lowest in Sub-Saharan Africa, countries in all Bank regions except South Asia exhibit a wide range of variation.
Table 3.1: Distribution of Country Probabilities of Project Success, by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Min</th>
<th>Median</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>0</td>
<td>64</td>
<td>100</td>
</tr>
<tr>
<td>Middle East, North Africa</td>
<td>0</td>
<td>71</td>
<td>100</td>
</tr>
<tr>
<td>South Asia</td>
<td>69</td>
<td>71</td>
<td>100</td>
</tr>
<tr>
<td>East Asia, Pacific</td>
<td>33</td>
<td>76</td>
<td>100</td>
</tr>
<tr>
<td>Latin American, Caribbean</td>
<td>0</td>
<td>76</td>
<td>100</td>
</tr>
<tr>
<td>East Europe, Central Asia</td>
<td>0</td>
<td>83</td>
<td>100</td>
</tr>
</tbody>
</table>

4. Environmental Resource Allocation by the World Bank

The World Bank's Environment Department has recently completed an accounting of environmental lending and AAA in seven thematic categories: climate change, pollution management, land management, biodiversity, water resource management, environmental policies and institutions, and other environmental management. This exercise has drawn on recent changes in the Bank's accounting system, which now tracks the allocation of funds across both sectors (e.g., environment, infrastructure) and themes within sectors (e.g., climate change, pollution management). The new system identifies the environmental components of projects whose sectoral identification is non-environmental. For example, transport-related projects often include components that promote reduction of vehicular air pollution.

This paper draws on information for all World Bank projects approved since FY 1998, and all AAA since FY 2000. Using the appropriate thematic codes, we calculate total Bank lending and AAA by country and environmental theme. Our five environmental indicators and the institutional problem indicator are constructed to match the corresponding thematic categories in the project database. The seventh thematic
category (other environmental management) has no direct analog, so we use the mean value of the five environmental indicators for our matching exercise.

Perhaps the most striking feature of the Bank's environmental lending is the stability of its thematic allocation over time. As Figure 4.1 shows, annual environmental lending declined from around $3.5 billion in FY 1993 to $1.0 billion in FY 2003. Despite this sharp change in aggregate lending, the regression results in Table 4.1 suggest that thematic shares remained stable: None exhibits a significant time trend since 1993.

Figure 4.1  World Bank Environmental Lending, 1993-2003 ($US Million)

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7 We have not analyzed thematic trends for AAA, since the available time interval is much shorter.
Table 4.1: Trend Tests for Thematic Shares

<table>
<thead>
<tr>
<th></th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policy</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>0.318</td>
<td>-0.167</td>
<td>0.639</td>
<td>0.074</td>
<td>0.008</td>
<td>-1.071</td>
<td>0.199</td>
</tr>
<tr>
<td></td>
<td>(0.63)</td>
<td>(0.19)</td>
<td>(1.38)</td>
<td>(0.37)</td>
<td>(0.01)</td>
<td>(1.65)</td>
<td>(1.09)</td>
</tr>
<tr>
<td>Constant</td>
<td>8.337</td>
<td>33.404</td>
<td>8.529</td>
<td>2.215</td>
<td>20.456</td>
<td>24.930</td>
<td>2.128</td>
</tr>
<tr>
<td></td>
<td>(2.44)*</td>
<td>(5.54)**</td>
<td>(2.72)*</td>
<td>(1.61)</td>
<td>(5.86)**</td>
<td>(5.67)**</td>
<td>(1.71)</td>
</tr>
<tr>
<td>Obs.</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.04</td>
<td>0.00</td>
<td>0.17</td>
<td>0.01</td>
<td>0.00</td>
<td>0.23</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Absolute values of t statistics in parentheses
* significant at 5%; ** significant at 1%

Produced by thousands of interactions between the Bank and its partner countries, these results suggest very strong continuity in the relative valuation of thematic objectives. We will return to this point in Section 7, which develops a model for the optimal allocation of environmental resource allocation by the Bank.

5. How Has Environment Mattered in the Aggregate?

We begin our assessment by analyzing the match between environmental lending, AAA and environmental problems at the country level. Our overall environmental indicator is the mean of the five thematic indicators. We use log values for the analysis because the size distributions of country indicators and resource allocations are extremely

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8 For biodiversity, our data include only Bank lending. Grants by the Global Environment Facility (GEF) for biodiversity conservation are not included in this analysis, but the GEF is currently conducting a parallel analysis of its own resource allocation.

9 All indicators are normalized to the range [0-100], so they have equal weight in determining the mean indicator.
As the scatter plot in Figure 5.1 suggests, the association between overall environmental problems and lending is very strong for those countries that have received environmental loans.

Figure 5.1: World Bank Environmental Lending vs. Overall Environmental Problems (Log Scale)

In a log-log regression of environmental lending on the overall environmental indicator (Table 5.1, column 1), the estimated response elasticity is .70, with an associated t-statistic of 10.3 and regression $R^2$ (adjusted for degrees of freedom) of .53.

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10 Conventional regression and correlation analysis assume that variable distributions do not contain extreme “outlier” observations, because such outliers can sharply skew the results. In this case, both nominal and per-capita distributions are extremely skewed. Log measures, on the other hand, have regular, approximately-normal distributions with no outliers.
Table 5.1: Determinants of Environmental Lending

<table>
<thead>
<tr>
<th></th>
<th>Environmental Lending&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Environmental AAA&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Log Overall Env.</td>
<td>0.700</td>
<td>0.425</td>
</tr>
<tr>
<td>Indicator</td>
<td>(10.35)**</td>
<td>(5.08)**</td>
</tr>
<tr>
<td>Log Bank Non-Env. Lending</td>
<td>0.437</td>
<td>0.402</td>
</tr>
<tr>
<td></td>
<td>(5.34)**</td>
<td>(4.70)**</td>
</tr>
<tr>
<td>Log Bank Env. Lending</td>
<td>0.015</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Log OED Success Probability</td>
<td>1.149</td>
<td>1.071</td>
</tr>
<tr>
<td></td>
<td>(3.35)**</td>
<td>(2.97)**</td>
</tr>
<tr>
<td>AFR (Sub-Saharan Africa)</td>
<td>0.245</td>
<td>0.474</td>
</tr>
<tr>
<td></td>
<td>(0.97)</td>
<td>(0.72)</td>
</tr>
<tr>
<td>EAP (East Asia, Pacific)</td>
<td>0.367</td>
<td>0.878</td>
</tr>
<tr>
<td></td>
<td>(1.14)</td>
<td>(1.28)</td>
</tr>
<tr>
<td>ECA (Europe, Central Asia)</td>
<td>0.813</td>
<td>0.388</td>
</tr>
<tr>
<td></td>
<td>(3.25)**</td>
<td>(0.69)</td>
</tr>
<tr>
<td>MNA (Middle East, N. Africa)</td>
<td>0.714</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>(2.02)*</td>
<td>(0.08)</td>
</tr>
<tr>
<td>SAR (South Asia)</td>
<td>0.459</td>
<td>-0.375</td>
</tr>
<tr>
<td></td>
<td>(1.21)</td>
<td>(0.47)</td>
</tr>
<tr>
<td>Constant&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.363</td>
<td>-4.160</td>
</tr>
<tr>
<td></td>
<td>(31.89)**</td>
<td>(2.85)**</td>
</tr>
<tr>
<td>Observations</td>
<td>92</td>
<td>91</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.54</td>
<td>0.70</td>
</tr>
<tr>
<td>Adj. R-Sq.</td>
<td>0.53</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Absolute value of t statistics in parentheses significant at 5%; ** significant at 1%

<sup>a</sup> Limited to countries with environmental lending
<sup>b</sup> Limited to countries with environmental AAA
<sup>c</sup> LCR (Latin America, Caribbean) is the excluded regional dummy variable.

This result suggests that a 1% increase in overall environmental problems is associated with a .70% increase in environmental lending. At the regional level, Figure 5.2 also suggests a good correspondence between overall environmental problems and environmental lending in countries where such lending has occurred. The relationship is very strong in East and South Asia (EAP, SAR), but it is also apparent in the other
regions. However, all regions (particularly AFR and LCR) include countries that have no lending, despite significant environmental problems.

**Figure 5.2: World Bank Environmental Lending by Region vs. Overall Environmental Problems (Log Scale)**

The number of such zero-lending cases suggests that the Bank's interaction with these countries has been affected by other factors. We introduce broader considerations into our regressions by including the Bank's total country lending and countries' OED project success rates, as well as regional differences. The results in columns 2 and 3 of Table 5.1 suggest that the Bank's overall lending relationship with a country and the country's project success rate are both significant determinants of environmental lending. The results in column 3 also indicate a significant component of environmental lending to two regions (ECA, MNA) that is not accounted for by our environmental problem indicator, project success rates, or other Bank lending.
Our results for total Bank lending are uniformly significant at the 99% level, and the results for the OED ratings are significant at the 95% level or higher. The parameter estimates suggest that a 1% increase in Bank lending is associated with a .4% increase in environmental lending, and a 1% increase in the OED rating is associated with an environmental lending increase of about 1%. Once we control for these two factors, environmental problems retain a significant impact on environmental lending at the 99% level. However, the estimated response elasticity drops from .70 to around .45.

The results for AAA in Figure 5.1 are quite different from the results for lending. The association with environmental problems is uniformly significant at the 99% confidence level, but we find no significance for environmental lending, non-environmental lending, the OED success probability, or any regional dummies. R-squares for the AAA regressions are much lower than R-squares for lending, suggesting a much greater random component in the allocation of AAA resources.

6. Allocation by Environmental Theme

From an institutional perspective, our overall results for lending are encouraging because they suggest that large, politically-difficult reallocations across countries would not generally be necessary to bring country lending into alignment with overall environmental problems. The implications for AAA may be more serious, since our results suggest that the association between AAA and environmental problems explains only a small component of the cross-country variation in AAA.

We extend the analysis to the thematic level, by regressing lending and AAA for each theme on the associated environmental problem indicator (Table 6.1). The results for lending suggest strong relationships that mirror the overall relationship captured by
Table 5.1 For each of the six themes, lending is positively associated with the relevant indicator at a very high level of significance. Estimated elasticities are generally near 0.5, except for biodiversity (0.3) and policies and institutions (1.2). However, the low R-squares suggest that most thematic lending is determined by other factors. For AAA, the results are even weaker. Regression R-squares are extremely low, and thematic AAA is not significantly associated with the relevant thematic indicator in 3 of 6 cases. We find positive, significant associations for climate change, water resources and policies and institutions.

Overall, the relationship between AAA allocations and indicator values appears to be nearly random. Although our results indicate significant relationships between lending and environmental problems, the low R-squares also imply considerable scope for better matching between needs and resources. In the following sections, we develop and implement a model that we believe can assist in this task.

7. Optimal Thematic Lending and AAA

Following Buys, et. al (2003), we model the welfare impact of World Bank investments as a function of their levels and distributions across countries. We recognize that the Bank must strike a balance between country representation and global welfare maximization in its resource allocation decisions. To reflect this balance, we assume that the Bank's welfare function is characterized by unit-elastic substitution across countries. A unit-elastic (Cobb-Douglas) function permits tailoring of programs to a country's circumstances, while encouraging portfolio diversification through the operation of diminishing returns. In our model, expected welfare gains from Bank investments are related to both the scale of a
Table 6.1: Regression Results: Thematic Lending, AAA and Environmental Indicators

Environmental Thematic Lending vs. Thematic Indicator Values
(Limited to Countries with Environmental Lending)

<table>
<thead>
<tr>
<th>Log Environmental Indicators</th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>0.469</td>
<td>0.460</td>
<td>0.459</td>
<td>0.320</td>
<td>0.553</td>
<td>1.214</td>
</tr>
<tr>
<td></td>
<td>(2.86)**</td>
<td>(3.30)**</td>
<td>(3.18)**</td>
<td>(3.32)**</td>
<td>(4.33)**</td>
<td>(6.26)**</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.519</td>
<td>0.686</td>
<td>-0.572</td>
<td>-2.907</td>
<td>0.115</td>
<td>-0.996</td>
</tr>
<tr>
<td></td>
<td>(7.51)**</td>
<td>(1.80)</td>
<td>(1.53)</td>
<td>(10.56)**</td>
<td>(0.30)</td>
<td>(3.09)**</td>
</tr>
<tr>
<td>Observations</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td>91</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.08</td>
<td>0.11</td>
<td>0.10</td>
<td>0.11</td>
<td>0.17</td>
<td>0.31</td>
</tr>
<tr>
<td>Adj. R-Sq.</td>
<td>0.07</td>
<td>0.10</td>
<td>0.09</td>
<td>0.10</td>
<td>0.16</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Environmental Thematic AAA vs. Thematic Index Values
(Limited to Countries with Environmental AAA)

<table>
<thead>
<tr>
<th>Log Environmental Indicators</th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>0.680</td>
<td>0.297</td>
<td>0.367</td>
<td>0.144</td>
<td>0.522</td>
<td>1.131</td>
</tr>
<tr>
<td></td>
<td>(3.18)**</td>
<td>(1.14)</td>
<td>(1.36)</td>
<td>(0.77)</td>
<td>(2.23)*</td>
<td>(3.34)**</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.142</td>
<td>-1.454</td>
<td>-2.653</td>
<td>-2.163</td>
<td>-0.379</td>
<td>-1.016</td>
</tr>
<tr>
<td></td>
<td>(8.05)**</td>
<td>(2.87)**</td>
<td>(5.98)**</td>
<td>(4.68)**</td>
<td>(0.74)</td>
<td>(1.80)</td>
</tr>
<tr>
<td>Observations</td>
<td>63</td>
<td>63</td>
<td>63</td>
<td>63</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.14</td>
<td>0.02</td>
<td>0.03</td>
<td>0.01</td>
<td>0.08</td>
<td>0.15</td>
</tr>
<tr>
<td>Adj. R-Sq.</td>
<td>0.12</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.06</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
country's environmental problems and the probability that projects will be successful under local conditions. We assume that the Bank assigns the same opportunity values to human life, health and natural resource savings in all of its partner countries. From these assumptions, we derive a simple optimal allocation rule (Buys, 2003): *For a particular environmental theme (e.g., pollution, threats to biodiversity), each country's optimal share of available lending and AAA resources is proportional to the product of its problem scale and the probability of project success.*

Do our assumptions, and the resulting allocation rule, actually reflect the Bank’s operational experience? To check for general consistency, we have estimated cross-country equations in which the log of the Bank’s environmental lending and AAA are regressed on the logs of the overall environmental index and the OED measure of success probability (Table 7.1). Our simple allocation rule implies that the parameters of both variables are equal to one. Using the standard F-test for the lending and AAA equations, we find that these parameter values cannot be rejected at the standard significance level (5%) in either case. We conclude that the Bank’s environmental lending and AAA have been broadly consistent with our allocation rule. However, the high degree of unexplained variation in both regressions suggests large gaps between actual and optimal allocation in many cases.

Our model addresses the allocation problem within each environmental theme, but it cannot determine thematic allocations from total lending resources. However, our historical results for thematic lending shares (Section 4) have strong significance in this context. The stability of these shares, in the face of sharp changes in total environmental lending, suggests a clear pattern of preferences underlying the Bank's many transactions.
with partner countries. We accept these overall preferences, and assume that future thematic lending shares will be identical to the lending shares for the period 1998 - 2003.

**Table 7.1: Tests of the Cobb-Douglas Allocation Rule:**
Environmental Lending and AAA
(Standard errors in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Log Lending</th>
<th>Log AAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Environmental Problem Indicator (EPI)</td>
<td>1.136 **</td>
<td>1.265 **</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.21) **</td>
</tr>
<tr>
<td>Log OED Success Probability (OSP)</td>
<td>2.602 **</td>
<td>1.143</td>
</tr>
<tr>
<td></td>
<td>(0.73)</td>
<td>(0.87)</td>
</tr>
<tr>
<td>Constant</td>
<td>-9.960 **</td>
<td>-5.099</td>
</tr>
<tr>
<td></td>
<td>(3.09)</td>
<td>(3.67)</td>
</tr>
<tr>
<td>Observations</td>
<td>139</td>
<td>139</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.28</td>
<td>0.21</td>
</tr>
<tr>
<td>Adj. R-Squared</td>
<td>0.27</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>F [EPI = OSP = 1]</strong></td>
<td>2.65</td>
<td>0.78</td>
</tr>
<tr>
<td><strong>Prob. &gt; F</strong></td>
<td>0.07</td>
<td>0.46</td>
</tr>
</tbody>
</table>

significant at 5%; ** significant at 1%

We also use the lending shares as guidelines for AAA, since the Bank’s analytical and advisory activities are supposed to serve its lending program.

Table 7.2 presents percent changes associated with movement from actual to optimal lending by sector and region. In Sub-Saharan Africa, for example, the overall gap between actual and optimal environmental lending is small (+5%), but thematic gaps vary from around -40% for climate change and biodiversity to +64% for land. South Asia has a relatively large overall gap (+33%), and thematic gaps ranging from -60% or less for biodiversity and climate change to over +180% for land and water resources. In a strongly-contrasting pattern, Latin America and the Caribbean have a relatively large overall gap (-26%), with increases for climate change (+127%) and biodiversity (+17%) and decreases for land and water resources (-70% and -9%, respectively). Across
regions, moving from actual to optimal lending results in increases for Africa (5%), East Asia / Pacific (20%) and South Asia (33%), and decreases for Europe / Central Asia (-57%), Latin America / Caribbean (-26%) and Middle East / North Africa (-19%).

Table 7.2: % Differences Between Actual and Optimal Lending

<table>
<thead>
<tr>
<th>Region</th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policies</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFR</td>
<td>-41</td>
<td>30</td>
<td>64</td>
<td>-44</td>
<td>13</td>
<td>0</td>
<td>-65</td>
<td>5</td>
</tr>
<tr>
<td>EAP</td>
<td>23</td>
<td>21</td>
<td>27</td>
<td>90</td>
<td>-14</td>
<td>57</td>
<td>99</td>
<td>20</td>
</tr>
<tr>
<td>ECA</td>
<td>-15</td>
<td>-46</td>
<td>-85</td>
<td>-70</td>
<td>-61</td>
<td>-61</td>
<td>-26</td>
<td>-57</td>
</tr>
<tr>
<td>LCR</td>
<td>127</td>
<td>-30</td>
<td>-70</td>
<td>17</td>
<td>-9</td>
<td>-40</td>
<td>-16</td>
<td>-26</td>
</tr>
<tr>
<td>MNA</td>
<td>*</td>
<td>-20</td>
<td>138</td>
<td>*</td>
<td>-63</td>
<td>-20</td>
<td>97</td>
<td>-19</td>
</tr>
<tr>
<td>SAR</td>
<td>-62</td>
<td>-4</td>
<td>181</td>
<td>-69</td>
<td>212</td>
<td>14</td>
<td>-12</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Estimates reflect changes from actual to optimal lending
* Division by 0 in growth rate calculation

Tables 7.4 and 7.5 present % differences for AAA under two assumptions. Table 7.4 holds thematic AAA shares constant at their levels for 2000-2003, while Table 7.5 assumes that thematic AAA shares are equal to thematic lending shares for 1998-2003. The differences between the two tables are evident, reflecting the substantial differences between thematic shares for lending and AAA in Table 7.3. Lending shares are higher for climate, pollution, land and water, while AAA shares are higher for biodiversity and environmental policies and institutions. The difference for pollution is particularly striking (31% of lending vs. 10% of AAA).


<table>
<thead>
<tr>
<th>Resource</th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policies</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lending</td>
<td>10</td>
<td>31</td>
<td>15</td>
<td>3</td>
<td>23</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>AAA</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td>19</td>
<td>27</td>
<td>21</td>
</tr>
</tbody>
</table>

At the regional level, Tables 7.4 and 7.5 show that the change in assumptions makes little difference for allocations. Whether or not thematic lending shares are used for
AAA allocation, the pattern of regional change in AAA is similar to the pattern for lending (with the exception of Africa): Two regions have increases in AAA (East Asia / Pacific, South Asia) and four regions have decreases (Africa, Europe / Central Asia, Latin America / Caribbean and Middle East / North Africa). Furthermore, the magnitudes of overall regional changes are almost identical in Tables 7.4 and 7.5 (again, Africa excepted)

However, changing thematic shares from the AAA allocation to the lending allocation has a large impact on thematic results. Moving to the lending allocation (Table 7.5) entails very large increases for three sectors (climate (118%), pollution (198%), land (107%)) and large decreases for two (biodiversity (-73%), policies and institutions (-44%)). Overall, combining these changes with regional shifts generates much larger regional % changes within sectors in Table 7.5 than in Table 7.4. In some cases, change patterns are replicated in the two tables (e.g., large % increases in climate, pollution and land for EAP; decreases for all themes except water in ECA). However, other patterns are reversed, particularly for biodiversity, which gets a much larger allocation in Table 7.4 (10% of total AAA) than in Table 7.5 (3% of total lending).

Table 7.4: % Differences Between Actual and Optimal AAA (AAA Thematic Shares Held Constant)

<table>
<thead>
<tr>
<th>Region</th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policies</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFR</td>
<td>-35</td>
<td>20</td>
<td>-62</td>
<td>-75</td>
<td>-81</td>
<td>146</td>
<td>-56</td>
<td>-52</td>
</tr>
<tr>
<td>EAP</td>
<td>171</td>
<td>271</td>
<td>411</td>
<td>222</td>
<td>50</td>
<td>-8</td>
<td>88</td>
<td>61</td>
</tr>
<tr>
<td>ECA</td>
<td>-63</td>
<td>-83</td>
<td>-65</td>
<td>-87</td>
<td>2</td>
<td>-66</td>
<td>-71</td>
<td>-68</td>
</tr>
<tr>
<td>LCR</td>
<td>473</td>
<td>64</td>
<td>-86</td>
<td>90</td>
<td>13</td>
<td>25</td>
<td>-26</td>
<td>-7</td>
</tr>
<tr>
<td>MNA</td>
<td>-5</td>
<td>-59</td>
<td>279</td>
<td>-12</td>
<td>-69</td>
<td>19</td>
<td>-49</td>
<td>-39</td>
</tr>
<tr>
<td>SAR</td>
<td>-62</td>
<td>9</td>
<td>2,273</td>
<td>100</td>
<td>366</td>
<td>59</td>
<td>1,313</td>
<td>144</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 7.5: % Differences Between Actual and Optimal AAA
(AAA Thematic Shares = Lending Thematic Shares)

<table>
<thead>
<tr>
<th>Region</th>
<th>Climate</th>
<th>Pollution</th>
<th>Land</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Policies</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFR</td>
<td>42</td>
<td>258</td>
<td>-20</td>
<td>-93</td>
<td>-77</td>
<td>37</td>
<td>-92</td>
<td>-52</td>
</tr>
<tr>
<td>EAP</td>
<td>490</td>
<td>1,007</td>
<td>955</td>
<td>-14</td>
<td>76</td>
<td>-49</td>
<td>-67</td>
<td>56</td>
</tr>
<tr>
<td>ECA</td>
<td>-20</td>
<td>-48</td>
<td>-28</td>
<td>-97</td>
<td>20</td>
<td>-81</td>
<td>-95</td>
<td>-66</td>
</tr>
<tr>
<td>LCR</td>
<td>1,150</td>
<td>388</td>
<td>-70</td>
<td>-49</td>
<td>33</td>
<td>-30</td>
<td>-87</td>
<td>-18</td>
</tr>
<tr>
<td>MNA</td>
<td>108</td>
<td>24</td>
<td>684</td>
<td>-76</td>
<td>-63</td>
<td>-34</td>
<td>-91</td>
<td>-37</td>
</tr>
<tr>
<td>SAR</td>
<td>-17</td>
<td>224</td>
<td>4,804</td>
<td>-47</td>
<td>448</td>
<td>-11</td>
<td>146</td>
<td>166</td>
</tr>
<tr>
<td>Total</td>
<td>118</td>
<td>198</td>
<td>107</td>
<td>-73</td>
<td>18</td>
<td>-44</td>
<td>-83</td>
<td>0</td>
</tr>
</tbody>
</table>

Our results also suggest possible differences in the relative magnitudes of thematic changes for lending and AAA. Appendix Table 2 presents results for actual and optimal lending and AAA across sectors and regions. We estimate the relative magnitudes of thematic gaps by calculating the absolute values of regional thematic gaps as percentages of actual thematic allocations. For each theme, the sum of absolute-value percentage gaps provides an indicator of relative “misallocation”. Table 7.6 summarizes the results for three cases: lending, AAA (A -- with thematic AAA shares), and AAA (L -- with thematic lending shares). Both nominal and rank correlations suggest that misallocations are most closely matched for lending and AAA(A) shares; poorly matched for lending and AAA(L); and weakly matched for AAA(A) and AAA(L). We conclude that statements about thematic misallocation are highly sensitive to the comparison standard, and general conclusions do not seem appropriate.
Table 7.6: Thematic Misallocation Measures

<table>
<thead>
<tr>
<th>Theme</th>
<th>Lending</th>
<th>AAA (A)</th>
<th>AAA (L)</th>
<th>Lending</th>
<th>AAA(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>45</td>
<td>89</td>
<td>142</td>
<td>AAA(A)</td>
<td>0.67</td>
</tr>
<tr>
<td>Pollution</td>
<td>22</td>
<td>82</td>
<td>239</td>
<td>AAA(L)</td>
<td>-0.32</td>
</tr>
<tr>
<td>Land</td>
<td>70</td>
<td>127</td>
<td>181</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>68</td>
<td>105</td>
<td>73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>49</td>
<td>83</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policies</td>
<td>38</td>
<td>35</td>
<td>48</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme</th>
<th>Lending</th>
<th>AAA (A)</th>
<th>AAA (L)</th>
<th>Lending</th>
<th>AAA(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>AAA(A)</td>
<td>0.89</td>
</tr>
<tr>
<td>Pollution</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>AAA(L)</td>
<td>-0.09</td>
</tr>
<tr>
<td>Land</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policies</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Future Opportunities for Thematic Lending

To assess future opportunities, we assume that total environmental lending during the period 2004-2009 will be identical to lending during 1998-2003 ($9.2 billion). For each country, the optimal share of environmental lending by theme is proportional to the product of the country's thematic indicator and its OED success probability. To calculate optimal lending, we multiply each country's optimal thematic share by total thematic lending for the period 1998-2003. Then we add across themes to obtain total optimal lending for each country. Recognizing that the Bank may limit its lending to some countries for a variety of reasons, we derive a control factor from lending experience during the past six years. Across countries, the maximum ratio of environmental loans to total loans was 46%. As Figure 8.1 shows, most ratios were 10% or less.
Figure 8.1: Size Distribution of Ratios: Environment Lending / Total Lending, 1998 - 2003

Setting the maximum ratio at 40%, we identify a country's future environmental lending opportunity as the lower of two numbers: our estimate of total optimal environmental lending, or 40% of total lending during 1998 - 2003. With this control, the environmental lending opportunity is our optimal lending estimate for 83% of the 150 countries in our dataset. For the others, we use the 40% ratio to keep environmental lending within a plausible bound. Having determined the overall lending opportunity, we multiply by our optimal thematic shares to estimate thematic lending opportunities. We present the results in Appendix 1, with countries in each region sorted by total lending opportunity. The regional tables display historical lending, as well as future opportunities.

To illustrate, the six Sub-Saharan African countries with the highest environmental lending opportunities are Nigeria ($144 million), Ethiopia ($128 million),
Tanzania ($76 m.), Uganda ($38 m.), Mozambique ($35 m.), Congo DR ($32 m.), and Madagascar ($30 m.). Our results suggest that lending opportunities are generally largest for pollution management, although sizable opportunities also exist for land management, water resource management, and environmental policies and institutions. The mix of opportunities differs substantially by country, reflecting differences in their environmental problems. Other regions exhibit similarly-diverse patterns.

We summarize our results Table 8.1, which includes all countries with environmental lending opportunities of $50 million or more during the period 2004-2009. Of the 23 countries listed, 7 are in the East-Asia Pacific Region (EAP), 4 in Latin America and the Caribbean (LCR), and 3 are in each of the other regions. If, as we assume, AAA priorities should reflect lending priorities, then these same 23 countries should also form the core group for AAA during the period 2004-2009. AAA priorities for other countries would reflect the same rank-order as the lending opportunities in Appendix 1.

9. Interpretation of Results: Ethiopia vs. Nigeria

We provide an illustrative interpretation of our results by comparing the cases of Ethiopia and Nigeria in Table 9.1. Both have been among the Bank’s top borrowers in Sub-Saharan Africa: From 1998-2003, Nigeria borrowed $912 million and Ethiopia borrowed $1,381 million. Among the 48 Sub-Saharan countries, Nigeria’s overall environmental problem indicator ranks first and Ethiopia’s second. Both countries are in the midrange for the OED project success rate (45% for Nigeria; 65% for Ethiopia). After adjusting for success rates, Nigeria’s optimal lending is $144 million and Ethiopia’s is $128 million.
<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Lending Opportunity, 2004-09 ($ Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAP</td>
<td>China</td>
<td>2,904</td>
</tr>
<tr>
<td>SAR</td>
<td>India</td>
<td>1,405</td>
</tr>
<tr>
<td>EAP</td>
<td>Indonesia</td>
<td>548</td>
</tr>
<tr>
<td>SAR</td>
<td>Bangladesh</td>
<td>345</td>
</tr>
<tr>
<td>SAR</td>
<td>Pakistan</td>
<td>299</td>
</tr>
<tr>
<td>LCR</td>
<td>Brazil</td>
<td>241</td>
</tr>
<tr>
<td>LCR</td>
<td>Mexico</td>
<td>186</td>
</tr>
<tr>
<td>ECA</td>
<td>Russian Federation</td>
<td>153</td>
</tr>
<tr>
<td>AFR</td>
<td>Nigeria</td>
<td>144</td>
</tr>
<tr>
<td>MNA</td>
<td>Iran (Islamic Republic of)</td>
<td>140</td>
</tr>
<tr>
<td>EAP</td>
<td>Philippines</td>
<td>138</td>
</tr>
<tr>
<td>EAP</td>
<td>Vietnam</td>
<td>138</td>
</tr>
<tr>
<td>MNA</td>
<td>Egypt, Arab Republic of</td>
<td>138</td>
</tr>
<tr>
<td>AFR</td>
<td>Ethiopia</td>
<td>128</td>
</tr>
<tr>
<td>EAP</td>
<td>Korea, Republic of</td>
<td>103</td>
</tr>
<tr>
<td>ECA</td>
<td>Turkey</td>
<td>102</td>
</tr>
<tr>
<td>ECA</td>
<td>Ukraine</td>
<td>99</td>
</tr>
<tr>
<td>EAP</td>
<td>Thailand</td>
<td>93</td>
</tr>
<tr>
<td>LCR</td>
<td>Argentina</td>
<td>87</td>
</tr>
<tr>
<td>EAP</td>
<td>Malaysia</td>
<td>78</td>
</tr>
<tr>
<td>AFR</td>
<td>Tanzania</td>
<td>76</td>
</tr>
<tr>
<td>LCR</td>
<td>Peru</td>
<td>56</td>
</tr>
<tr>
<td>MNA</td>
<td>Yemen, Republic of</td>
<td>50</td>
</tr>
</tbody>
</table>

With this information as background, it is instructive to compare actual total and thematic lending. Ethiopia’s actual lending is in the same range as its optimal lending: $159 million. As Table 9.1 shows, Ethiopia ranks high in all environmental indicator categories except climate change. However, the pattern of thematic lending bears almost no relationship to Ethiopia’s thematic rankings in Africa, or to its optimal thematic lending. Climate is the most obviously-divergent category, with optimal lending of $2.1 million and actual lending of $71.8 million. Lending amounts for pollution management
and land and water resource management are far lower than the optimal levels, while lending for policies and institutions is substantially higher.

Nigeria’s case is even more divergent than Ethiopia’s. Despite the highest ranking in Sub-Saharan Africa for environmental problems and $144 million in optimal lending, Nigeria’s actual lending is only $2.5 million. Two themes – pollution and water resource management – have very small loans, and the others none at all.

Table 9.1 Environmental Indicator and Lending Status of Ethiopia and Nigeria Within Sub-Saharan Africa

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9. Summary and Conclusions

In this paper, we have used new environmental and accounting information to address four questions about the World Bank's environmental lending:

(1). Have the Bank's patterns of country environmental lending and AAA reflected cross-country differences in environmental problems?

Our evidence suggests an affirmative answer for both lending and AAA. At the country level, we find a strong association between both environmental lending and AAA and the overall severity of environmental problems. This association remains strong after we adjust allocations for project risks.
(2) Within countries, have the Bank's thematic lending and AAA reflected the relative incidence of thematic problems?

The evidence here is mixed. For each of the six themes, lending is positively associated with the relevant environmental indicator at a very high level of significance. However, the low R-squares for our regressions suggest that most thematic lending is determined by other factors. For AAA, the results are even weaker, suggesting a nearly-random relationship between risk-adjusted environmental priorities and resource allocation.

(3) If resource allocation is not aligned with problems, how large a change would realignment entail?

All of our results assume that future resources for environmental lending and AAA will be equal to resources during the past several years. If more resources become available, it might well be possible to increase lending and AAA for all regions and themes.11 With fixed resources, however, both our lending and AAA results imply significant reallocations from ECA and MNA to EAP and SAR. For AFR, our results suggest a modest increase in lending and a significant decrease in AAA. Both lending and AAA results suggest moderate decreases for LCR. If we adopt lending shares for AAA, our results also suggest large increases in AAA for climate change, pollution, and management of land and water resources, and substantial decreases for biodiversity and environmental policies and institutions.

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11 Even if more resources were available, of course, relative optimal allocations would reflect the patterns displayed by our fixed-resource allocations.
To achieve a good match in the future, how should the Bank identify a desirable portfolio of environmental lending in each partner country?

Using our optimal allocation model, we have developed estimates of thematic opportunities for the Bank's lending and AAA for the period 2004-2009. We recognize that these estimates (in Appendix 1) can only be suggestive, since the lending process is complex and uncertain. In addition, thematic opportunities in some countries may well be captured by other donors. Nevertheless, the numbers in Appendix 1 reflect an important new body of comparative information. We hope that our opportunity estimates will provide useful insights for our colleagues in the Bank, our partner countries, and other donor institutions.
References


Appendix 1

Environmental Lending Opportunities by Bank Region:
($US Million)

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East Asia and Pacific (EAP)
Europe and Central Asia (ECA)
Latin American and Caribbean (LCR)
Middle East and North Africa (MNA)
South Asia (SAR)
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APPENDIX 2
Actual vs. Optimal Lending and AAA

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(c) Actual Lending => Optimal Lending by Theme
Changes as % of Actual Thematic Totals
(Absolute Values)

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(c) Actual AAA => Optimal AAA by Theme

Changes as % of Actual Thematic Totals

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APPENDIX 3

Comparative Indicators of Country Environmental Problems

In Section 2, we introduce an overall environmental problem indicator that combines indices for five themes: global emissions, pollution, natural resource degradation, biodiversity threats, and water-related problems. To assure equal weighting in the overall indicator, we normalize each thematic index to the range [0-100] and compute the average value of the five indices. Our indicator is specifically tailored for this exercise, because each thematic index matches a category in the World Bank's budget tracking system. However, we recognize that indexing overall environmental problems need not be confined to equal-weighted aggregation of the five thematic indices. In this appendix, we assess the generality of our approach by comparing our overall indicator with others that are based on different aggregation strategies.

We begin by noting significant differences in the units of measurement for our thematic sub-indices. Three are based on DALY-equivalent losses (air pollution, water pollution, flood damage); two on polluting emissions (CO₂ from fossil fuel combustion and forest clearing); two on population pressure (populations occupying fragile lands and water-scarce areas); and two on threatened areas (terrestrial and marine biodiversity). In principle, we would prefer to aggregate across such indicators in common units. For example, our country indicators could tally total health or economic damage, if we had plausible factors for estimating the DALY- or economic-loss-equivalents of global emissions, population pressure on resources, and territorial biodiversity threats. Unfortunately, no broadly-accepted conversion factors exist, and valuation schemes based on human health or economic implications are particularly controversial in the biodiversity policy community.

We seek the middle ground by aggregating the thematic sub-indices into four categories that have common measurement units: DALY losses from pollution and water damage; population pressure on resources; global emissions; and threatened areas that have significance for biodiversity. To produce the four new indices, we add the sub-indices described in the previous paragraph, with one exception. Using GIS, we have computed the population occupying critical areas for terrestrial biodiversity. We treat this as another measure of population pressure on resources, and add it to our estimates for populations occupying fragile lands and water-scarce areas.¹² Since we have no reasonable way of computing equivalent populations for marine biodiversity, we retain its territorial index (% of worldwide reefs at risk).

We use two versions of the four-component index for comparison with our original five-theme index. First, we normalize each category (DALY losses, population pressure, global emissions, marine biodiversity) to the range [0-100] and compute the unweighted average. Second, we develop an index that gives heavy weight (.80) to DALY losses,

¹² This approach double- (or triple-) counts populations when they occupy overlapping areas for fragile lands, water scarcity, and terrestrial biodiversity. We believe that multiple-counting provides an appropriate indicator for pressure on diverse resources in this context.
and relatively small weights to population pressure (.10), global emissions (.05) and marine biodiversity (.05). Without claiming any precise validity for the implicit conversion factors, we offer this index as a crude approximation of present and discounted future impacts on human health. In any case, it provides a useful comparator with the unweighted average index.

Table A3.1 reports correlations for logs and ranks of the three overall indicators. We refer to the original (5-theme) and alternative (4-aggregate) indicators as Index 1 and Index 2, respectively. The results indicate that the choice of indicator makes little difference in practice: Both correlations between Index 1 and versions of Index 2 are .95 or higher, and the correlation of the Index 2 versions is .93. As Figure A3.1 shows, the high correlations among versions of Indices 1 and 2 reflect an extremely close relationship.

Table A3.1: Correlations Among General Environmental Indicators

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<th>Rank Correlations (150 observations)</th>
<th>Index 2 (.80 DALY wgt)</th>
<th>Index 2 (Equal Weights)</th>
<th>Index 1</th>
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<table>
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13 Again, we use logs and ranks to compensate for large scaling differences across countries.
Since the aggregation strategies for the two indices are so different, there is nothing automatic about these correlations. To show why the relationships are close, Table A3.2 displays rank and log correlations for the components of Indices 1 and 2. Associated overall indices are identified in parentheses. For population pressure, the table includes both the aggregated component (land, water, terrestrial biodiversity) and separate components for the two parts (land, water / terrestrial biodiversity).

Correlations in the first five rows of the tables are all very high, and they are also high in the next two rows. Only in the final row (for marine biodiversity) do low correlations appear. These results explain why the general indicators are so highly correlated. They would remain so unless marine biodiversity were given an extremely large weight in the overall index.
In this appendix, we have compared three different indicators for overall environmental problems in the World Bank's partner countries. One indicator is the unweighted average of indicators that match the Bank's thematic budget categories for environmental lending. The other two indicators are built from four components that reflect natural aggregation opportunities in the thematic subindices. We create different indicators with alternative weighting schemes for these four components: An unweighted average, and an index that gives disproportionate weight to measurable health damage. Despite the differences in aggregation strategy and component weighting, we find that the three general indices have extremely high correlations. These reflect very high correlations among index subcomponents, with the exception of the index for marine biodiversity.
APPENDIX 4

Country Environmental Indices
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