MEASURING INCLUSIVE GREEN GROWTH

March 2018

Inclusive and sustainable growth requires innovative methods and policies to overcome unsustainable development practices. Breaking from the historic development model to promote "clean" growth is necessary to ensure that developing countries do not degrade their environment as their economies grow, yet the measurement of this factor remains elusive in development work. To ease a shift in development practices, it is then crucial to develop meaningful measures of "Green Growth" to compare economic and environmental change over time. Here, we propose a multi-stage exercise to understand Green Growth, beginning with benchmarking national environmental stocks and ambient conditions. We then develop an approach to observe decoupling trends between environmental externalities and economic growth to better understand how a country's environmental and economic performance relate to one another at macroeconomic and sectoral levels. Based on the results of our baseline and decoupling exercises, we develop hypotheses to explain the observed relationships between economic and environmental indicators and the foundational factors that may underlie them. We explore these hypotheses through policy implications and methodological requirements, with the ultimate goal of explaining relationships related to developmental impacts on ecosystems. To illustrate this process, we focus on selected EU countries, drawing upon and complimenting World Bank Systematic Country Diagnostic[1] reports for Romania, Croatia, and Poland. Through this exercise, we conclude that the examination of baseline conditions and decoupling are useful tools for informed policymaking, and that with the availability of further refined data, Green Growth analyses can move toward understanding causal relationships between economic growth and environmental impacts, for which any one part of the analysis does not provide on its own.

[1] Systematic Country Diagnostic reports examine national economic performance related to the World Bank's Twin Goals of eliminating extreme poverty and boosting shared prosperity in a sustainable way. These reports are available online at https://openknowledge.worldbank.org/handle/10986/23099?locale-attribute=en.

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Introduction

Economic growth has served as the central component of development for generations, but is unsustainable in the long run unless it is both socially inclusive and environmentally sound. Inclusive and sustainable growth requires tackling political economy constraints, overcoming deeply entrenched behaviors and social norms, and developing innovative financing instruments to change incentives and promote innovation – and thus address the market, policy, and institutional failures that lead to the overuse of natural assets (World Bank 2012). Breaking from the historic development model of growing "dirty" and "cleaning up" later is necessary to ensure that developing countries do not degrade their environment as their economies grow.

Environmental performance does not automatically improve with income, yet the degradation of natural resources is sometimes seen as development's path of least resistance. When this destruction occurs, it can have devastating local impacts to human health and ecological stability, as well as global consequences related to climate change. Furthermore, it may be impossible or prohibitively expensive to "clean up" the mess of ecologically careless development, either because of the irreversibility of environmental damages like loss of biodiversity, or because lock-in prevents subsequent shifts to more environmentally benign structures and processes.

In general, it is agreed that sustainable economic growth requires the inclusion of environmental and social considerations (OECD 2011). Given the complexity in understanding how these different objectives are to be complementary and mutually reinforcing, there is a big push toward understanding, promoting, and achieving "Green Growth" as a greater goal. While various definitions are currently available, there is consensus that Green Growth embraces economic growth that is efficient and sustainable in the use of natural resources and minimizes negative environmental externalities, while aiming at improving the welfare of society (OECD 2011; World Bank 2012; UNEP 2011b). Inclusive Green Growth reaches further, stressing the importance of social equity in the distribution of economic and environmental benefits in addition to relaxing pressures on the environment (Green Growth Knowledge Platform 2013).

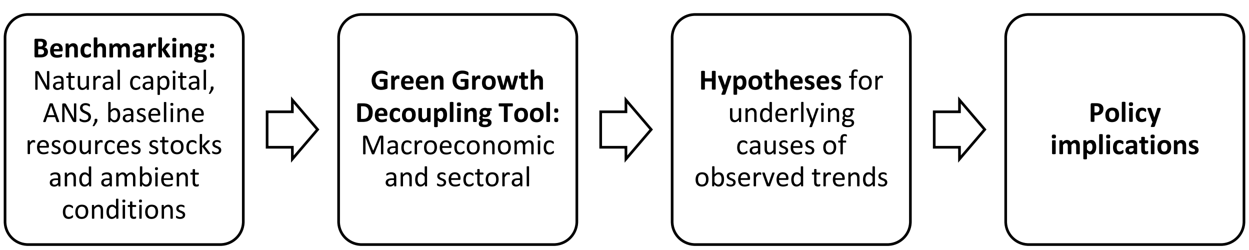
Two major barriers have stifled the proliferation of Green Growth as a development model. First, the pervasive conflation of market flows with overall wellbeing has long directed policy goals toward financial gain at the expense of other forms of capital. Second, straightforward and meaningful measurement of Green Growth has remained somewhat elusive, particularly at the sector level. While a global economic paradigm that is inhospitable to Green Growth initiatives may seem daunting, recent shifts toward the consideration of multidimensional wealth, rather than finance alone, show shifting attitudes toward benchmarking economic success. To facilitate this shift, it is then crucial to develop meaningful measures of Green Growth that compare economic and environmental indicators of interest over time.

A metric of "Green Growth" itself cannot be taken as a measure of sustainability, however, if the environmental conditions that underlie them are not understood. A situation where GDP is rising and deforestation is stagnant does not show whether deforestation rates are high or low, if a threat to forests is on the horizon, or if forests are even present in the studied country. Any form of growth measurement, therefore, must be understood alongside some level of benchmarking.

We propose here a benchmarking of national environmental stocks, taken in conjunction with an exercise to examine the relationship over time between economic growth and change in environmental externalities[1] using Eurostat data for selected countries in the EU. We develop an approach to observe decoupling trends between environmental externalities and economic growth to better understand how a country's economy and key sectors fare in terms of their environmental performance relative to its economic performance. This exercise can also reveal whether environmental externalities (either good, bad, or neutral) have a disproportional impact on the poorer regions within a country. This analysis also draws upon and compliments World Bank Systematic Country Diagnostic[2] reports for Romania, Croatia, and Poland, with examples from each referenced in subsequent sections.

In this paper, we first benchmark a country's environmental status based on current and historic ambient conditions, as well as natural capital stocks and adjusted net savings (ANS) to gauge its current environmental situation (Figure 1). For instance, we consider whether a country's ambient air quality complies with national and international standards. Second, the Green Growth Decoupling Tool is introduced with an illustrative example based on Romanian data. The decoupling tool reveals how a country or sector is performing vis-à-vis that specific environmental indicator relative to economic growth. Based on the results of this exercise, we then put forth potential hypotheses that may explain the decoupling relationships observed. We explore these hypotheses further through a discussion of spatial patterns of wealth distribution in relation to environmental factors. Finally, we present specific policy implications and recommendations on how to build the evidence base for policymaking.

Figure 1: Flow of Analysis



Benchmarking Environmental Quality through Wealth, Natural Capital and Baseline Conditions

The success of a country has long been considered through indicators of flow, with GDP as the leading measure. Problematically, however, this is analogous to measuring a company's performance by only

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[1] Externalities are side effects of production or consumption, which can be positive or negative. Belli et al. (2001) describe an externality as occurring when "production or consumption of a good or service by an economic agent has a direct effect on the welfare of other producers or consumers."

[2] Systematic Country Diagnostic reports examine national economic performance related to the World Bank's Twin Goals of eliminating extreme poverty and boosting shared prosperity in a sustainable way. These reports are available online at https://openknowledge.worldbank.org/handle/10986/23099?locale-attribute=en.

looking at its income statement (sales) and not its balance sheet – which includes income, assets and liabilities for a more complete picture of its overall sustainability. The flows accounted for do not necessarily reflect the wellbeing of a country or its population—finances may spike as a nation rebuilds in the aftermath of a natural disaster, for instance, yet this does not point to a society that is better off than before catastrophe struck. In recent years, there has been a growing call to account for stocks of wealth rather than flows of capital. Understanding the many forms of wealth that a country possesses does not tell a full story, however. It is critical to understand if wealth grows, is maintained, or depletes over time, and whether some forms of wealth are replaced by others. In this section, we offer insights to measuring a country's wealth and sustainable consumption through natural capital accounting and adjusted net savings[3], and discuss further baseline conditions of environmental health.

Natural Capital

Even when staying within the confines of the language of "capital" as wealth, several forms exist. Generally speaking, the total wealth of an economy can be defined as the sum of produced capital, human capital, and natural capital (plus net foreign assets). Natural capital comprises a significant portion of wealth in many countries, and supports the wellbeing and livelihoods of countless people.

In the example below, the portion of Romania's wealth in natural capital decreased 24% from 1995 to 2014, comprising only 16% of total wealth by the end of the period (see Figure 2; World Bank, forthcoming). The decline in the share of natural capital wealth in Romania does not necessarily indicate an absolute reduction in natural resources, yet decomposition indicates that this is the case in many areas (Table 1). The conversion of crop and pasture land, which comprise nearly two-thirds of Romania's natural capital wealth, serve as a main force of natural capital compositional change as they are replaced by urban areas (Figure 3). The decline of natural capital value is also explained to a smaller degree by declines in timber resources and sub-soil assets.

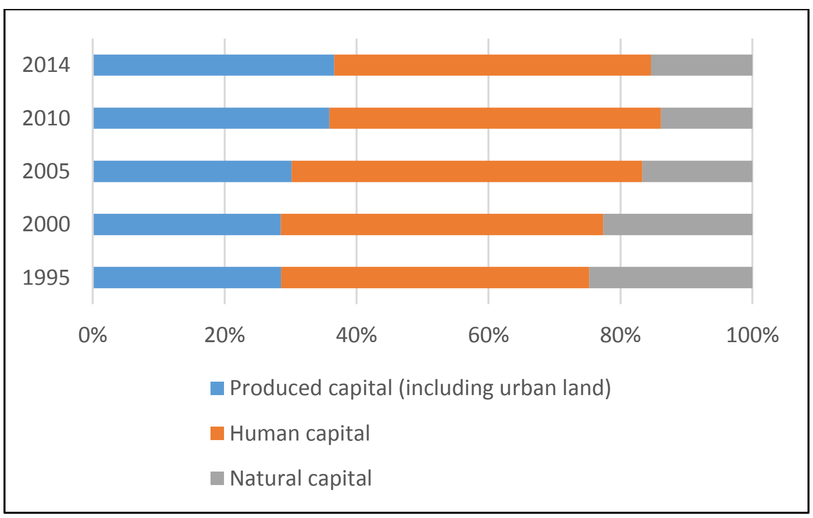


Figure 2. Change in the composition of Romania's total wealth over time

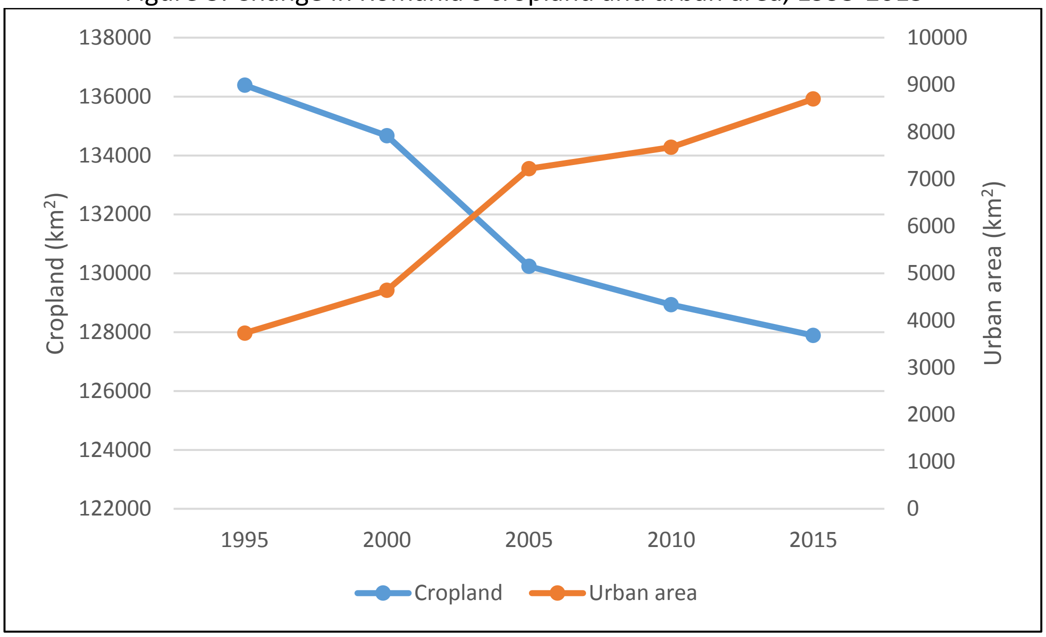
Table 1. Change in Romania's natural capital, 1995-2014 (millions, constant 2014 USD)

[3] Adjusted net saving (ANS) penalizes national net saving and for the value of resource depletion and environmental degradation, while crediting education expenditures as a proxy for human capital investment

Resource	1995	2000	2005	2010	2014	% change, 1995-2014
Forests, timber resources	27,435	17,987	13,943	9,625	10,744	-61%
Forests, non-timber resources	19,601	19,593	19,670	20,051	20,903	7%
Protected areas	15,981	16,345	***38,136***	40,787	64,668	305%
Land	307,401	249,436	238,557	200,246	209,622	-32%
Cropland	177,970	141,571	134,555	92,474	108,683	-39%
Pastureland	129,431	107,865	104,002	107,773	100,938	-22%
Sub-soil assets	55,842	41,403	40,626	30,901	37,800	-32%
Fossil energy resources	53,958	40,591	39,763	30,111	36,735	-32%
Oil	24,423	23,815	27,570	20,751	24,912	2%
Natural gas	27,363	16,329	10,132	5,593	9,333	-66%
Coal (all grades)	2,171	447	2,060	3,767	2,490	15%
Metals and minerals	1,884	812	863	790	1,065	-43%

Source: World Bank, Measures of Comprehensive Wealth, 2016.

Figure 3. Change in Romania's cropland and urban area, 1995-2015



Sources: World Bank using ESA-CCI Land Cover data (2017) and the Hidden Dimensions Dataset (2017)

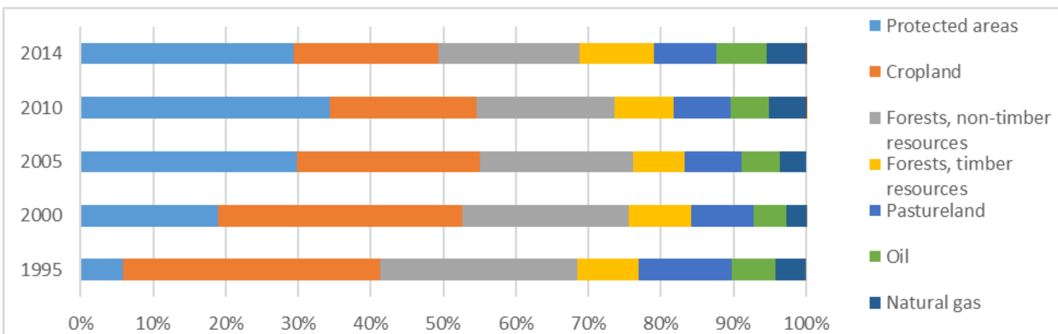
It is clear that some areas of natural capital are growing in Romania, however. Protected areas, for instance, grew substantially over the period from 1995 to 2014, due in large part to Romania declaring its Natura 2000 network[4] of protected areas leading up to its EU accession. It is likely that land was reclassified as protected area from other categories of land during this process (see 2005 figure highlighted in Table 1). Despite this shift, though, protected areas remain as a small share of overall natural capital value. The main driver of the decline in natural capital appears to be from the decline in crop and pasture land, -39% and -22% respectively. Using subnational land cover data derived from

[4] Natura 2000 is the centerpiece of EU nature policy. It is an EU-wide network of ***Natura 2000*** sites, established under the Birds and Habitats Directives. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats. Over 25,000 sites have already been designated, covering more than one million km^2.

remote sensing and geospatial data, we see that cropland shrunk by 8,499 km^2 while urban areas grew from 3,729 to 8,697 km^2 between 1995 and 2015 (Figure 3). The decline of natural capital value, although to a smaller degree, can also be explained by the decline in timber resources (-61%) and sub-soil assets (-32%).

Protected areas are also seen as a key feature in the natural capital[5] stock of Croatia, which benefits from tourism as a main contributor (Figure 4; World Bank 2017b). The direct contribution of tourism to GDP was 10.7 percent in 2016 (US$5.4 billion), and is forecasted to rise by 7.5 percent in 2017 and to grow 4.1 percent annually from 2017-2027[6]. Including indirect income effects, its contribution to GDP rose to over 25 percent in 2016 and is projected to rise to 32 percent by 2027. Tourism directly employs over 138,000 people (about 10 percent of total employment) and contributes indirectly to over 321,000 jobs (close to a quarter of total employment). Tourism growth is concentrated in specific counties and national parks. The number of tourist arrivals to Croatia increased from just over 9 million in 2006 to more than 15 million in 2016. This growth has been most acute in the national parks in Croatia, particularly Kornati and Krka which recorded a greater than 150 percent increase from 2011 to 2016. Tourist arrivals in Mljet, Plitvice lakes, Brijuni, and Paklenica national parks also grew more than 10 percent over this period.

Figure 4. Component shares of natural capital in Croatia (percent, 1995-2014)



Source: World Bank, Measures of Comprehensive Wealth, 2016.

In both Romania and Croatia, the expansion of protected areas leading up to their EU accessions signals the presence of a policy driver that has successfully promoted one form of natural capital. Despite this promising shift, other forms of natural capital clearly do not benefit from this same policy lever.

Adjusted Net Savings

By looking beyond financial flows alone, economists and other practitioners can account for stocks of infrastructure, investment in human wellbeing and achievement, and environmental resources, rather than treating these as sunk costs. In assessing the sustainability of these, however, one must consider the implications of substituting natural capital for other forms—constituting "weak sustainability"—or

[5] Natural capital is measured in this context as the monetary value of subsoil assets (10 minerals, 4 energy resources), agricultural land (crop and pasture), forest land (timber, Non-Wood Forest Products (NTFPs) and other services), and protected areas. For a detailed discussion of the valuation methodology see: *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (World Bank, 2011). Available at: https://siteresources.worldbank.org/ENVIRONMENT/Resources/ChangingWealthNations.pdf.

[6] World Travel and Tourism Council (2017). Travel & Tourism Economic Impact 2017: Croatia. Available at: https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2017/croatia2017.pdf.

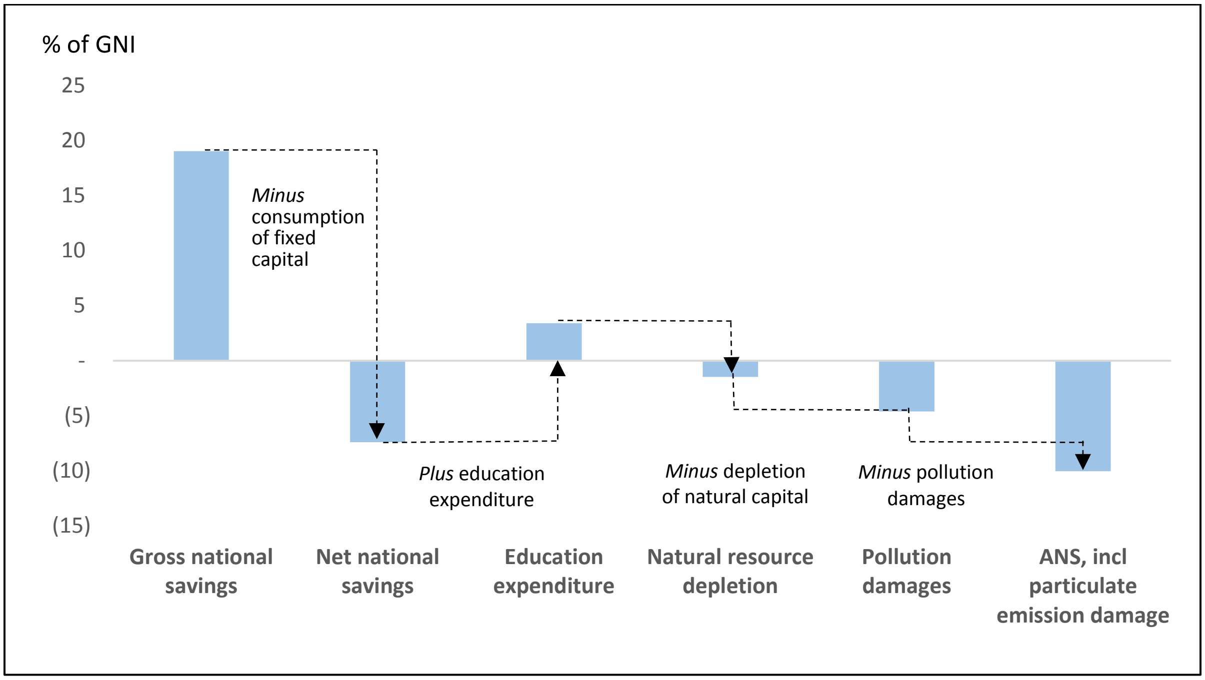
ensuring the protection of natural resources through a "strong sustainability" approach[7]. When a country over-exploits its renewable resources such as land resources or draws down its finite resources such as oil or mineral resources, it is depleting its natural capital and this should be accounted for in measuring sustainable growth. The omission is largely by construction, since the services that natural capital provides typically do not have explicit market prices or values and thus the full contribution is not included. For example, forests provide service flows such as carbon sequestration, erosion control and air filtration. The lack of elicitation of these values precludes their inclusion and means that the traditional measure of GDP can give misleading signals about the long-term economic performance and well-being of a country.

One way to account for sustainability is adjusted net saving (ANS), also called genuine saving, which adjusts national net saving for the value of resource depletion and environmental degradation, while crediting education expenditures as a proxy for investment in human capital. Negative ANS suggests that essential capital stocks are degrading, with worse impacts to future well-being. Positive ANS, conversely, indicates the addition of wealth and future well-being (Lange, Wodon, and Carey 2018).

A negative ANS highlights Romania's unsustainable savings and investment path in the 1990s. Gross national saving was 19% of Gross National Income (GNI). After adjusting for the consumption of fixed capital (minus 26.4%), education expenditures (plus 3.4%), depletion of natural resources (minus 1.5%), and pollution damages (minus 4.6%), Romania's adjusted net saving was around -10% percent of GNI (Figure *5*).

[7] Weak sustainability assumes unconditional substitution between the various kinds of capital – meaning that natural resources may decline as long as human capital is increased. Examples include the degradation of tropical forests and coral reefs if accompanied by benefits to human capital. On the other hand, strong sustainability assumes that the economic and environmental capital is complementary, but not interchangeable. Strong sustainability accepts there are certain functions that the environment performs that cannot be duplicated by humans or human made capital. The ozone layer is one example of an ecosystem service that is crucial for human existence, forms part of natural capital, but is difficult for humans to duplicate.

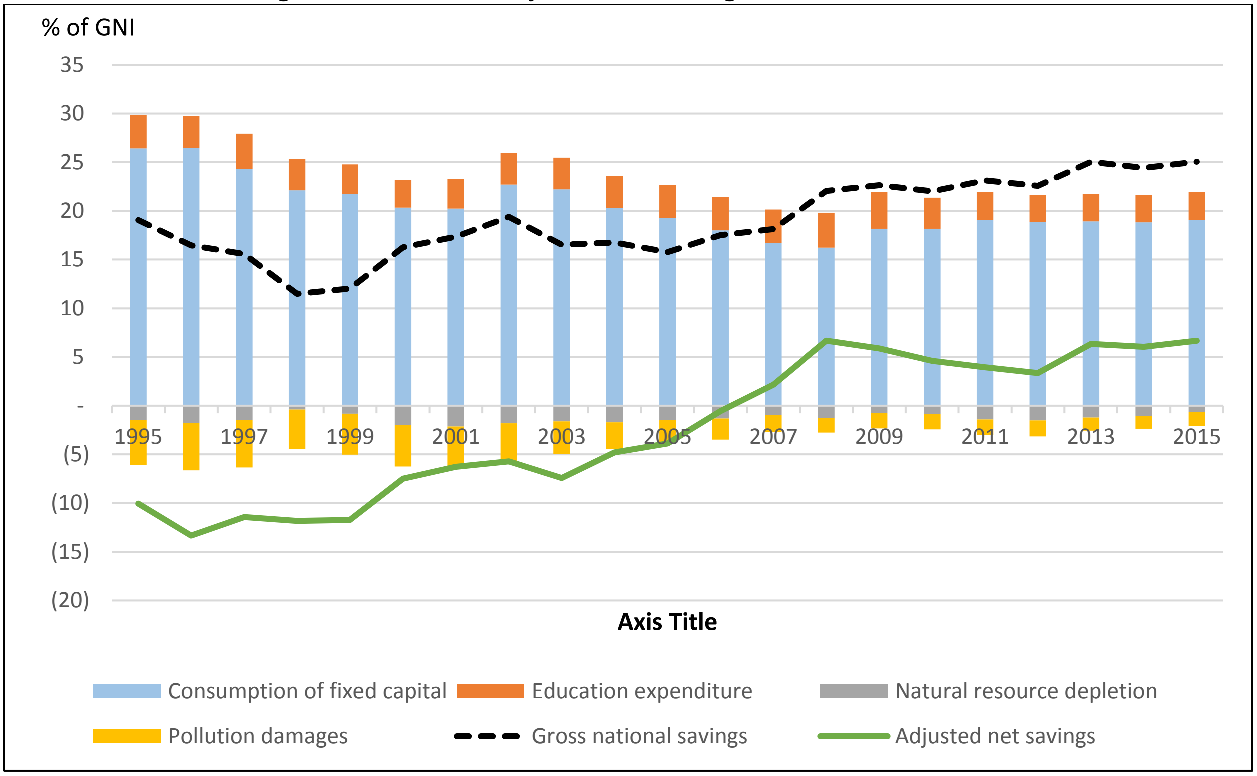
Figure 5. Calculating Adjusted Net Savings for Romania in 1995



Source: World Development Indicators 2016, World Bank

Romania's ANS improved over time, however, and became positive in 2007, owing to increased saving and reduced consumption – building greater 'economic resilience'. Romania's savings trend over the past two decades is shown in Figure 6, where the line graphs compare the country's gross national saving to its adjusted net saving from 1995 to 2015. Looking first at the trend in Gross National Savings (GNS), Romania's total resources available for investment remained between 15-20% from the mid-1990s to 2007, and increasing to around 25% by 2015. Though ANS generally tracked the movement of GNS, it remained below zero until 2007. Part of the convergence of ANS with GNS was due to a reduction in the consumption of fixed capital which fell from 26% in 1995 to 19% by 2015. Although more modest, the period was also characterized by gains from reduced CO_2 damage (i.e. falling from 4% to 1% of GNI) and particulate matter pollution (i.e. falling from 0.8% to 0.3%). Resources invested in education remained at only about 3% of GNI over the entire period. The period of negative ANS prior to 2007 and reaching near 7% of GNI by 2015 suggests that Romania has taken steps in saving and investing more, while moderating its consumption. Non-renewable resources are not large in Romania, so there is little to deplete and account for, but non-renewable resources such as land and forests do provide significant non-market benefits and wealth to the economy. The current path of saving and investing, as defined by ANS, appears to be on a much more sustainable growth path, and the steps taken since the late-1990s have built greater economic resilience.

Figure 6. Romania's Adjusted Net Saving over time, 1995-2015



Source: World Development Indicators 2016, World Bank

Baseline Conditions

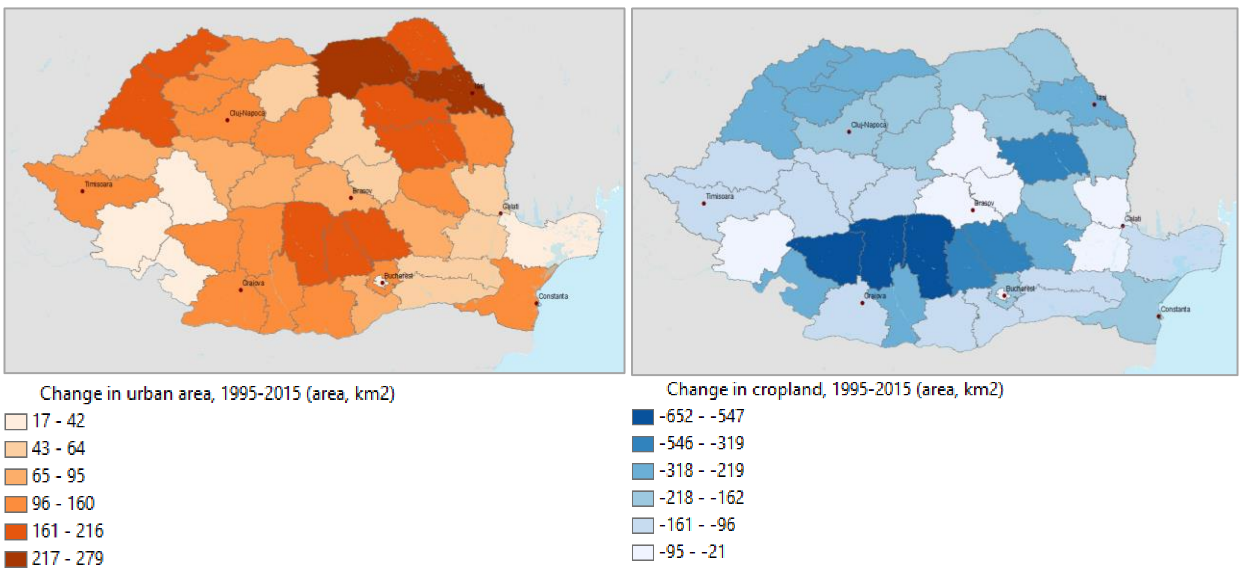
Composite measures of wealth are important for understanding macro-level trends, yet they are less functional at smaller scales, due largely to data limitations. Economic and environmental conditions can both be considered as baselines. The purpose of these measures is to provide a snapshot of national conditions and crucial aspects of understanding economic development, wealth, and wellbeing. At a local level, however, conditions can vary considerably, and can tell a much richer story of how natural capital is evolving.

Common environmental considerations include ambient air quality, forest cover and rate of loss or gain, water quality, and greenhouse gas emissions. Many other environmental indicators exist, however they may be limited in geographic scope or scale. Additionally, not all environmental factors are equally important within and between countries. In countries where forestry or fishing contribute to the livelihoods of a large population, deforestation and water quality may be of top concern, while other countries may be less dependent or not even have access to these resources. Within a county, ambient air quality may be of great concern in urban areas, but have relatively little impact on rural regions. Thus, a baseline environmental profile should be tailored to a country's landscape and include sub-national variation when possible.

Economic baselines should also take into account the specific areas of concern in a country. Understanding which sectors are most economically important, the extent of poverty and inequality in a country, and regional economic diversity are all key baseline factors. Tying these to environmental variables is also important—for instance, in understanding the economic implications of landscape changes.

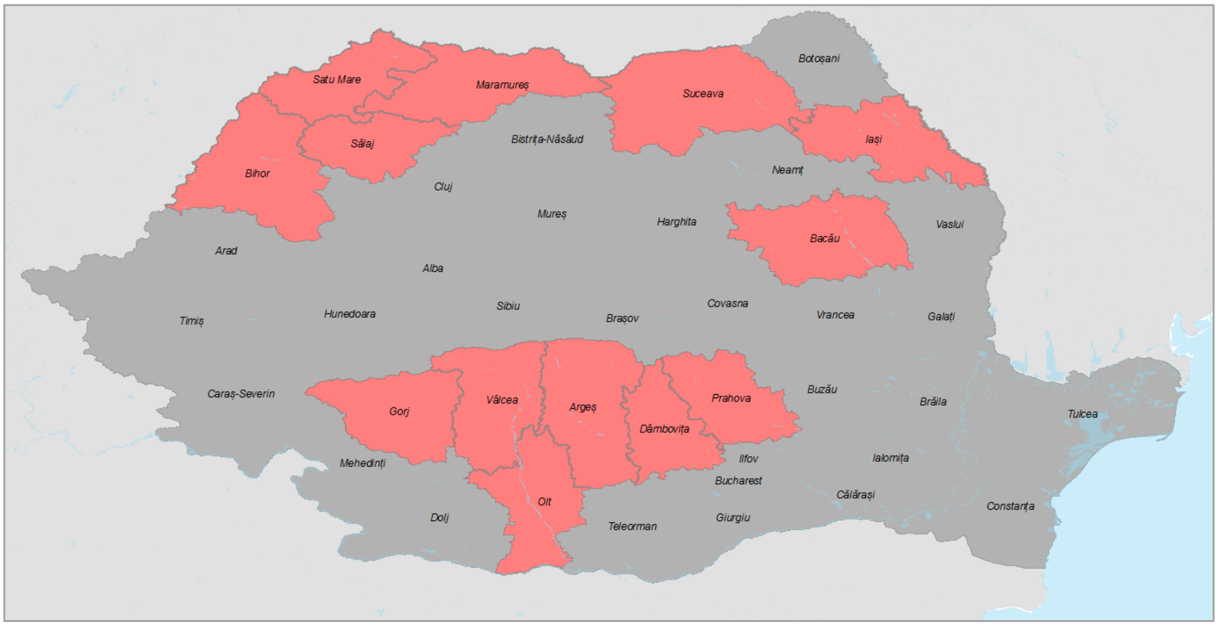
Using the example of Romania, changes in land use reveal potential political and economic links. As with positive changes in protected areas, other types of land conversion are of concern to natural capital. Urban expansion is concentrated in the northeast, with the provinces of Suceava and Lasi recording more than 217 km^2 of new urban areas (Figure 7). And the decline in croplands is concentrated in the central-south area, with the provinces of Gorj, Valcea and Arges decreasing by more than 547 km^2. The land conversion hotpots, or provinces with significant urban expansion and cropland decreases, are concentrated in the north and south of the country (Figure 8). Conversion is most prevalent in the provinces of Bihor, Salaj, Satu Mare, Maramures, Suceava, Iasi, Bacau, Gorj, Valcea, Arges, Olt, Dambovita, and Prahova.

Figure 7. Changes in urban area and cropland, Romania 1995-2015



Sources: World Bank using ESA-CCI Land Cover data (2017) and the Hidden Dimensions Dataset (2017)

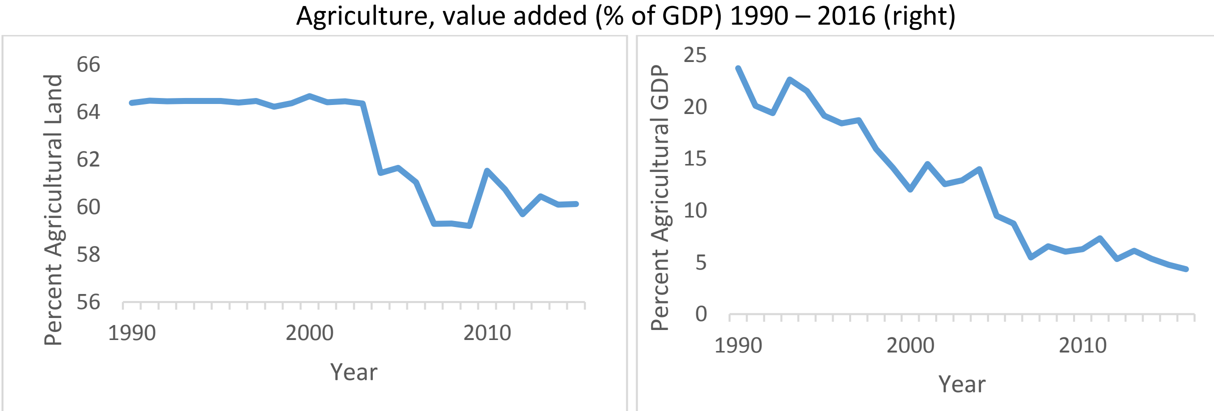
Figure 8. Land conversion hotspots in Romania



Note: Land conversion hotspots refer to provinces where urban expansion is greater than the mean, and cropland is declining greater than the mean
Sources: World Bank using ESA-CCI Land Cover data (2017) and the Hidden Dimensions Dataset (2017)

Changes in land use also reflect economic shifts such as a decline in both agricultural land and the prominence of the agricultural sector in Romania (Figure 9). The bulk of agricultural land decline occurred during the period of EU accession, indicating a potential link with the reclassification of protected areas.

Figure 9: Agricultural land (% of land area) in Romania, 1990 - 2015 (left)
Agriculture, value added (% of GDP) 1990 – 2016 (right)



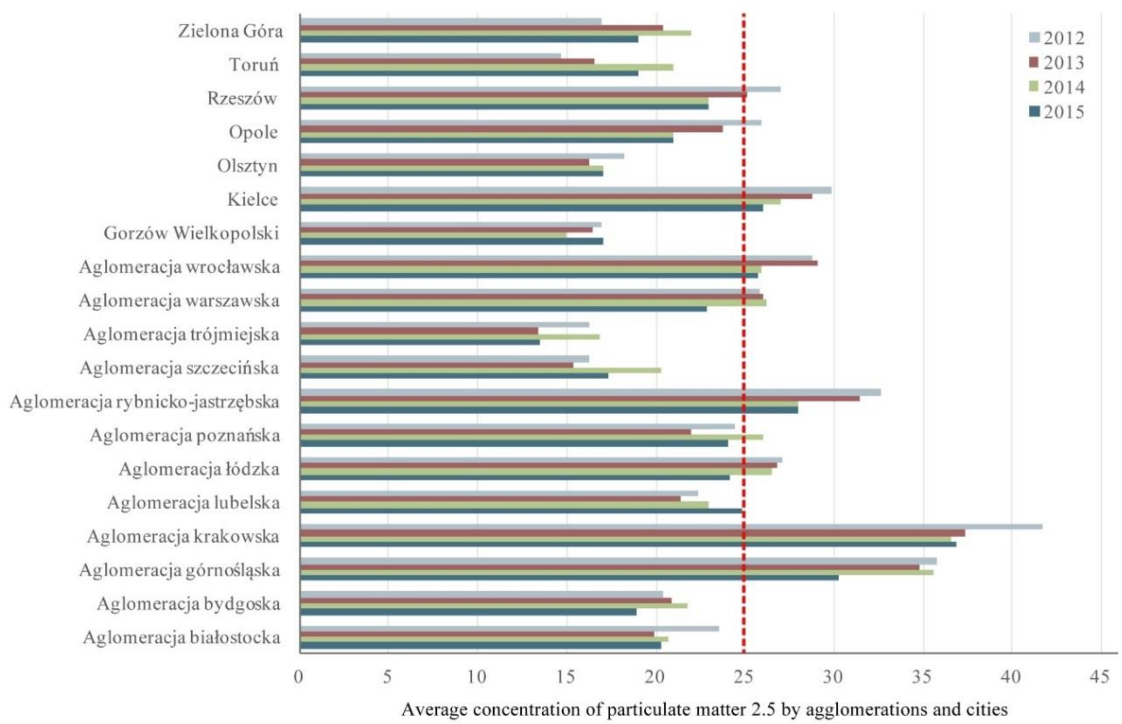
Source: World Development Indicators, 2018

Land conversion should account for the ecological service functions of the land to maintain resilience to natural disasters and the effects of climate change. In Romania, land resources are the most important component of natural capital. Land provides direct economic benefits as it is an input to production (provisioning services), but it also provides other non-monetized functions such as flood protection (regulating services) and supporting services, such as maintaining nutrient cycles and crop pollination. Unmanaged land conversion eliminates valuable ecosystems, their services, degrades 'buffer' systems, undermines livelihoods and therefore resilience. While land conversion itself is not necessarily bad, it can be done quite well, it should account for the full range of service functions to understand the potential tradeoffs in doing so.

Poland offers another example of the importance of local and baseline conditions (World Bank 2017a). While the country has made significant progress in improving its air quality related to SO_2, NOx, and heavy metals, yet it is remains out of compliance with EU standards with respect to fine Particulate Matter (PM)[8]. In Poland, $PM_{2.5}$ concentrations are slightly decreasing over time, with an average drop of 5 percent between 2012 and 2015, yet several areas still exceed the limit value of 25 μg/m^3 (Figure 10). At the individual city level, though, the air quality situation is much more nuanced. Out of a total of 154 cities that were monitored, approximately 23 percent were above the limit value of 40 μg/m^3 for PM_{10} and twice as many were out of compliance for $PM_{2.5}$ standards.

What both country cases imply is that targeted interventions can be made to improve overall environmental performance – once the determinants of these externalities are more fully understood.

Figure 10. Average concentration of $PM_{2.5}$ by agglomeration and selected cities, 2012-2015



Source: Poland Inspectorate for Environmental Protection, 2016.

[8] Particulate matter 2.5 ($PM_{2.5}$) refers to particles with a diameter of 2.5 micrometers or less, and PM_{10} refers to particles less than 10 microns in diameter. PM is either directly emitted as primary particles or comes from emissions of SO_2 and NOx.

Examining Beyond the Baseline

Knowledge of a country's environmental profile over time opens several questions: are trends in environmental quality a result of economic growth? If so, what type of relationship does economic growth have with various environmental factors? Does all economic growth have the same function? And if economic growth is not a driver of environmental trends, could natural capital flows be related to other factors such as policy or investment trends?

Together, changes in natural capital, overall ANS, and ambient conditions can provide a baseline assessment of environmental quality. While these aspects are central to understanding a country's environmental context, they do not link trends in economic growth and environmental externalities. Applying these baseline measures to analyses such as decoupling provide essential knowledge to inform potential links between environmental and economic facets.

Green Growth Decoupling Tool

Analysis at the Macroeconomic Level (Aggregate Analysis)

To analyze the relationship between growth and natural capital, we consider both macroeconomic[9] indicators and aggregate environmental indicators. A country's macroeconomic performance can be measured at a basic level using gross domestic product (GDP) and total employment figures. While GDP is a problematic measure (as discussed above), including this in a decoupling exercise can highlight how factors such as environmental quality are taken for granted in this type of metric. The analysis can be expanded by decomposing the main components of GDP, namely household consumption expenditure, government expenditure, investment, and net exports of goods and services. These components may be further decomposed into sub-components, such as net exports into total exports and total imports depending on the importance of these indicators relative to the environmental issues examined. Investment is measured through gross capital formation. The economic indicator values are expressed in constant prices relative to a base year.[10]

Environmental indicators track environmental stocks, greenhouse gas (GHG) emissions, and natural resource use, as well as policies that encourage green growth and the economic opportunities that result from them. Variation in the type of indicators chosen should reflect national and regional differences in environmental conditions and the relative importance of natural resources in their economy. The current study relies on data available from Eurostat, which provides comparable data across the EU, as member countries report to this common database. Available reported indicators may include greenhouse gas emissions, sulphur oxides, nitrogen oxides, particulates < 10µm (PM_{10}), final energy consumption, water

[9] This note uses indicator definitions adopted by the World Development Indicators (WDI) (wdi.worldbank.org) Different databases may use different indicators and definitions; where necessary, such differences will be highlighted in this text.

[10] More specifically, Eurostat uses the chain-linking approach. http://ec.europa.eu/eurostat/statistics-explained/index.php/HICP_methodology.

abstraction, total consumption of fertilizers, environmental protection expenditure, total environmental taxes, and municipal waste (landfill/disposal).

Alternative data also exists beyond Eurostat (i.e., Green Growth Knowledge Platform 2013; World Bank 2016b, 2016a, 2016c, 2016d, 2016e, 2018), which can be used to complement the Eurostat set of indicators or analyze non-EU countries. The Green Growth Knowledge Platform, for example, was established by the Global Green Growth Institute, the Organization for Economic Co-operation and Development, the United Nations Environment Programme, and the World Bank in 2012, establishing a common set of indicators to enable consistent and comparable monitoring of progress across countries (Green Growth Knowledge Platform 2013). Common indicators are classified under four main headings: environmental and resource productivity[11] or intensity, natural asset base, environmental quality of life, and policies and economic opportunities.

Indicators of *environmental and resource productivity and intensity* aim to measure whether growth or output and consumption are achieved with fewer natural resource inputs, including less pollution and a lower reliance on environmental services. In the case of Eurostat, these indicators include greenhouse emissions, total consumption of fertilizers, and municipal waste (landfill/disposal). *Natural asset base indicators* gauge the sustainability of natural resource depletion and/or degradation and flag risks to future growth and well-being posed by current overuse, for example, final energy consumption. Indicators of *environmental quality of life* capture the impact on people's health and well-being through access to environmental services and amenities, exposure to air pollution, water pollution, hazardous substances and noise; transformation in the water cycle; biodiversity loss; and natural disasters. The green growth diagnostic uses the common term "negative environmental externality" to designate such phenomena. Examples include sulphur oxides, nitrogen oxides, particulate matter concentrations, and water abstraction. Finally, indicators of *policy and economic opportunities* measure a government's efforts to stimulate sustainable production and consumption, encourage the development and use of new technologies and innovations, discourage unsustainable use of natural resources and energy, and employment or other new economic opportunities associated with green growth. In Eurostat, this includes environmental protection expenditure, and total environmental taxes. For comparisons with macroeconomic data, the starting point would be to use national level / aggregate data, such as greenhouse gas emissions.

Sector Level Analysis

A deeper analysis is possible by exploring linkages between economic and environmental indicators at various sector and sub-sector levels. The key limitation to expansion at the sector level is the availability of data, and in the case of Eurostat, especially for the environmental indicator data. Decoupling exercises can focus on "impact" decoupling (i.e. focusing on economic indicators, such as GDP or EVA, and environmental externalities such as water or air pollution levels), or "resource" decoupling (i.e. trends

[11] Also referred to as "efficiency" in some publications/statistical data books, such as Statistics Netherlands as in Baldé and Baas (2013)

between economic indicators, and resource indicators, such as water abstraction or final energy consumption). Our examples focus mainly on impact decoupling due to data limitations.

Economic Sector and Green Growth Indicators

The key sectors that make up GDP (from the supply side) are agriculture, industry, and services. Growth in these sectors is measured in terms of "value-added" data. When data is available, these sectors may be further disaggregated as:

- Agriculture: Crop cultivation, livestock production, forestry, fishing, hunting.
- Industry: Mining, manufacturing, construction, electricity, water, gas.
- Services: Wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services.

In addition to "value-added" data, the Eurostat sectoral indicators include employment, final consumption expenditure, stock of vehicles, and final energy consumption (transport sector) for some of the countries in the EU.

Analysis can involve a combination of sectors and sub-sectors depending on their relative importance in a given country's economy. These can use disaggregated data of relevant environmental indicators for each sector or sub-sector. Table 2 presents some examples of potential sector and sub-sector analyses based on the Eurostat data. The extent to which an economic indicator can be matched with an environmental indicator depends also on the time series of available data. When available economic and environmental indicators cannot be matched, additional data sources may be required for data augmentation.

Table 2. Example sector and environmental indicator comparisons

Sector / Sub-sector	**vs.**	**Environmental Indicator Specific to Sector/Subsector**
Agriculture value added	vs.	GHG, SO_x, NO_x, PM_{10}, final energy consumption, environmental protection expenditure, water abstraction
Manufacturing value added	vs.	GHG, SO_x, NO_x, PM_{10}, environmental protection expenditure.
Industry value added	vs.	Environmental protection expenditure
Construction value added	vs.	GHG, SO_x, NO_x, PM_{10}
Utilities value added	vs.	GHG, SO_x, NOx, PM_{10}
Mining value added	vs.	SO_x, NOx, PM_{10}, environmental protection expenditure
Transport stock of vehicles	vs.	GHG, SO_x, NO_x, PM_{10}, final energy consumption
Households final consumption	vs.	SO_x, NO_x, PM_{10}, final energy consumption
Energy generation value added	vs.	GHG, SO_x, NO_x, PM_{10}, environmental protection expenditure
Services value added	vs.	SO_x, NO_x, PM_{10}

Source: Eurostat and EEA in the case of GHGs.

In cases where data for economic and environmental indicators are obtained from different sources, sector/sub-sector classifications may not be fully compatible. For example, diagnostic analyses for Bulgaria, Croatia, and Romania required data for GHG emissions were sourced from the European Energy

Agency, which has GHG emissions data for “energy industries”, while economic data were obtained from Eurostat, which has value added data for “electricity” only. Nevertheless, in these countries, electricity is the dominant form of energy generated; therefore, two datasets could be combined (World Bank 2016b, 2016c, 2016d).

Presentation and Functionality

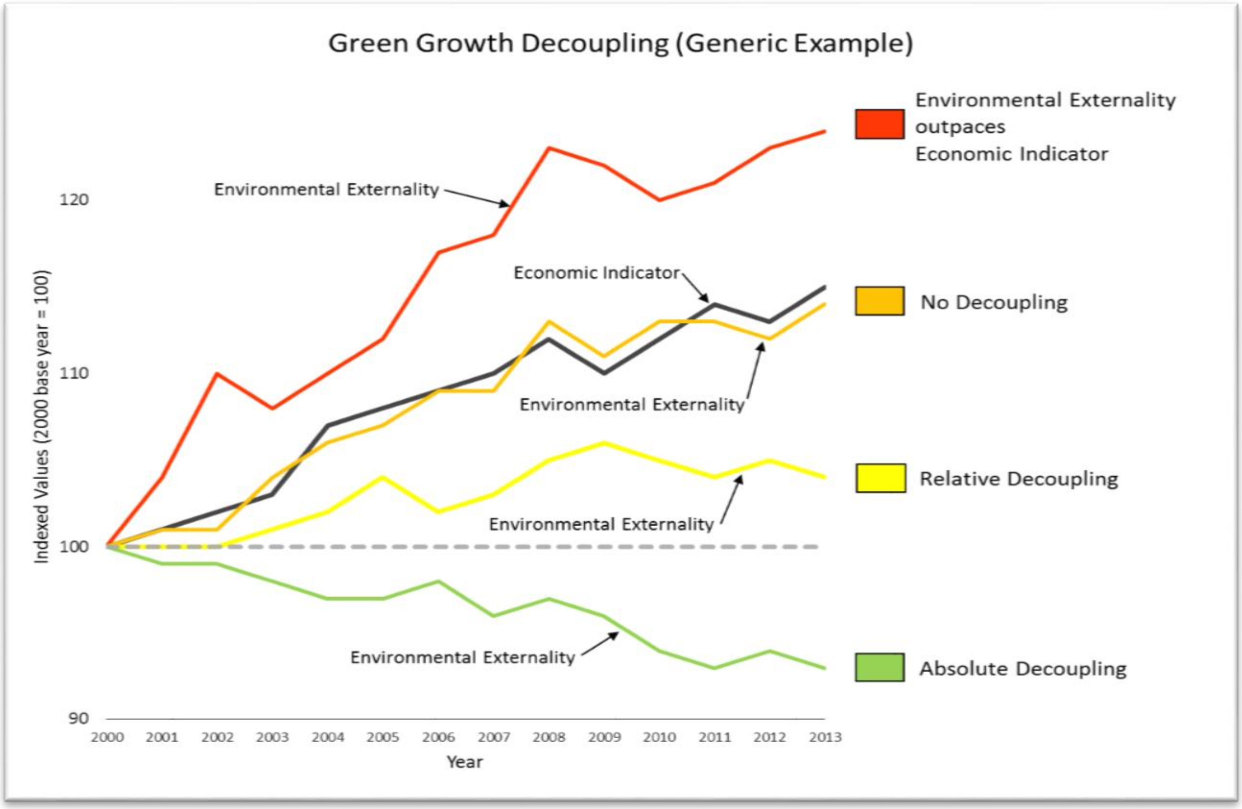
The methodology used here builds on the concept of decoupling between economic growth and the growth of negative environmental externalities. In the context of Green Growth, decoupling is defined as using fewer resources per unit of economic output (resource decoupling) and reducing the negative environmental impact of any resources used or economic activities undertaken (impact decoupling) (UNEP 2011a). Depending on the data available, countries can benefit from analysis of resource decoupling (e.g. GDP and energy consumption), impact decoupling (e.g. Economic Value Added and SOx emissions), or both. Decoupling can be “absolute”, “relative”, or “negative”; or there may be no decoupling at all[12].

- Absolute decoupling is said to occur when a negative environmental externality is decreasing while the economy (or a sector of the economy) is growing, when compared to a reference level (i.e. base year).
- Decoupling is said to be relative in the following two cases. First, decoupling is relative when the growth rate of the environmental externality is positive, but lower than the growth rate of the economic indicator. Second, decoupling is said to be relative when both the environmental externality and the economic indicator decrease below a reference level.
- Decoupling is negative when a negative environmental externality grows at a higher rate than the economic indicator.
- Finally, no decoupling occurs when both the economic indicator and the environmental externality are growing at approximately the same rate.

Figure 11 provides a visual representation of the decoupling concept, but does not show the second case of relative decoupling (i.e. both the economic indicator and the environmental externality are decreasing compared to the base period). The color scheme shown in this figure is used in subsequent examples to identify different types of decoupling.

[12] For further elaboration of the types of decoupling covered here, see Appendix 1.

Figure 11. Green Growth Decoupling – Generic Example



Source: Eurostat, 2016

The decoupling framework can also be applied to other positive environmental issues such as environmental expenditures, or positive externalities such as land conservation. In such cases, the conditions for "absolute", "relative", and "negative decoupling are reversed, while that for "no decoupling" is the same. For example, consider the Environmental Protection Expenditure (EPE) in Romania[13]. Based on the decoupling definitions, the exercise would indicate negative decoupling, as the growth in environmental expenditures is greater than GDP growth. However, assuming efficiency in the usage of the environmental budget, environmental protection expenditure can be considered to have a positive effect on the environment. Thus, this decoupling can be interpreted as green decoupling (i.e., "absolute decoupling").

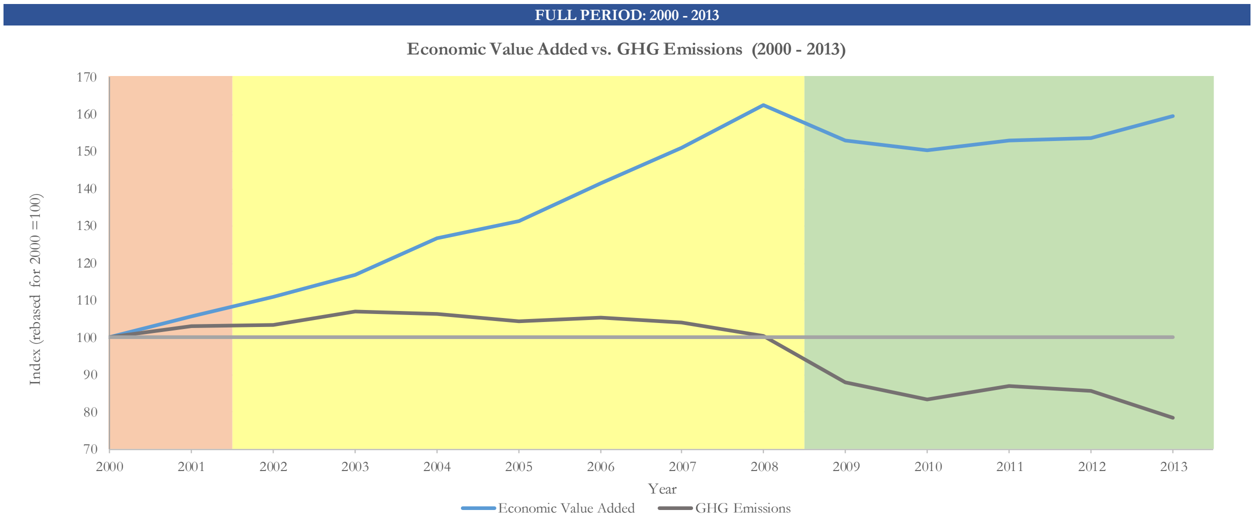
The case of Romania allows decoupling analysis where time series data for Economic Valued Added (EVA) and Greenhouse Gas emissions (GHG) is available for the period 2000-2013. The decoupling trend of EVA and GHG emissions generated by all sectors of the economy for the entire period of study are presented in Figure 12[14]. Following the types of decoupling shown in Figure 11, three periods of decoupling between

[13] In 2007, the rebased EPE is 415.79, while the rebased GDP is 176.67.

[14] The intensity value is defined as the ratio of the amount of externality (numerator) over the value of the economic indicator (denominator). In other words, the intensity value signifies the environmental impact per economic unit, such as per dollar of GDP, of value added in agriculture, energy generation or manufacturing, or per dollar spent on consumer goods. Intensity values can be calculated for the entire economy, or for individual sectors and subsectors, depending on the availability of disaggregated data. The intensity value pertaining to the first and the final years in a time series, as well as, the percentage change in the intensity value over the period of

EVA and the GHG emissions emerge: no decoupling in the first two years of the analysis (orange), relative decoupling between 2002 and 2008 (yellow), and absolute decoupling beginning with 2009 (green).

Figure 12. Romania: Economic Valued Added versus Greenhouse Gas Emissions (2000-2013)



Absolute Decoupling					
2000 Intensity Value:	2.63	**2013 Intensity Value:**	1.29	**% Intensity Change**	-50.8%

Source: Green Growth Decoupling Tool (World Bank, 2016).

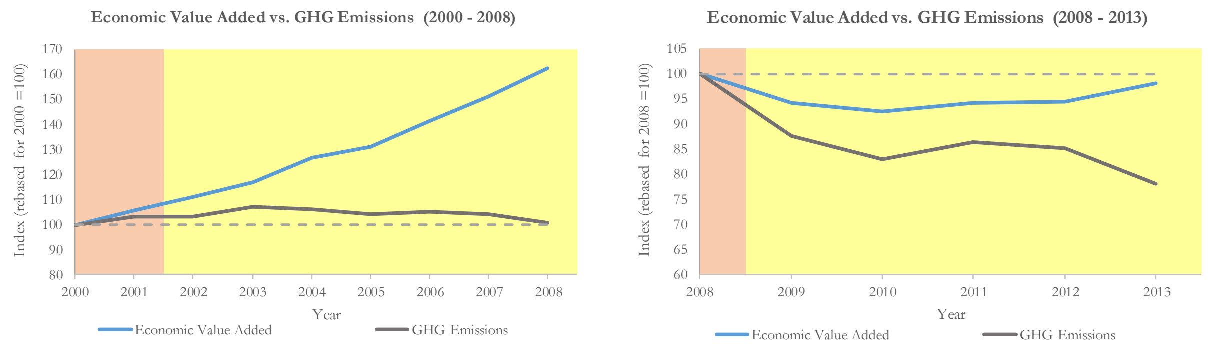
A closer looks revels that the EVA growth was curbed in 2008, which is also the first year the GHG emissions descend below the base year level of emissions. Prior to 2008, EVA followed an ascending trend, while the GHG emissions kept steady at a level above the base year. Romania's accession to the European Union in 2007 may explain the ascending trend in the economic indicator, while the global financial crisis hit in 2008. Considering these facts, is the absolute decoupling between 2009-2013 real or it is just an artifact of the base year? To answer this question, separate analyses can be performed for data prior and post 2008, as illustrated in

Figure *13*.

Figure 13. Romania: Economic Valued Added versus GHG Emission (2000 -2008 and 2008 -2013)

analysis is presented at the bottom of each decoupling trend figure. Fundamentally, the decoupling measures and the intensity approach provide the same information, but in a slightly different form. A detailed discussion of this point is provided in Appendix 1.

ANALYSIS WINDOW 1: 2000 - 2008	ANALYSIS WINDOW 2: 2008 - 2013

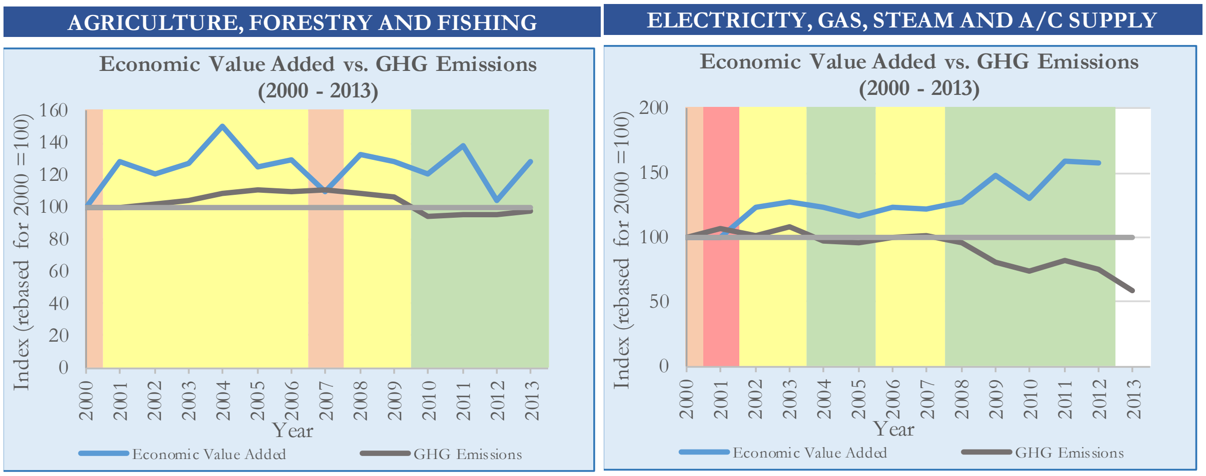


Relative Decoupling		Relative Decoupling	
2000 Intensity Value:	2.63	**2008 Intensity Value:**	1.63
2008 Intensity Value:	1.63	**2013 Intensity Value:**	1.29
% Intensity Change	-38.2%	**% Intensity Change**	-20.4%

Changing the base year and looking at decoupling before and after 2008 shows that GHG emissions decrease after 2008, but so does EVA. Thus, instead of absolute decoupling, the period following the 2008 financial crisis is characterized by relative decoupling between EVA and GHG emissions. Further analysis could explain how much of the gap between the EVA and GHG emissions is due to gains in technical efficiency as compared to loss in economic growth.

Additional insights regarding the drivers behind the aggregate decoupling trends can be obtained from the analysis of various economic sectors. Figure 14 shows the decoupling trends between EVA and GHG emissions in Agriculture and Electricity sectors. In terms of decoupling sequencing, both agriculture and energy sectors follow similar trends to that in Figure 14 - an initial period of relative decoupling followed by one of absolute decoupling. However, differences between the two sectors and the overall economy are present. The EVA in agriculture follows a cyclical trend with a low point in 2007. Among other factors, this could be explained by the weather risk faced by the Romanian farmers and possibly underutilized insurance markets. The EVA in the electricity sectors follows an ascending trend even after 2008, while GHG emissions start decreasing around the same time. This could provide evidence of true absolute decoupling between the EVA and GHG emissions and could be explained by long term investments in the sector prior to the financial crisis.

Figure 14. Romania: Economic Value Added vs. GHG Emissions –Sector Analysis (2000-2013)[15]

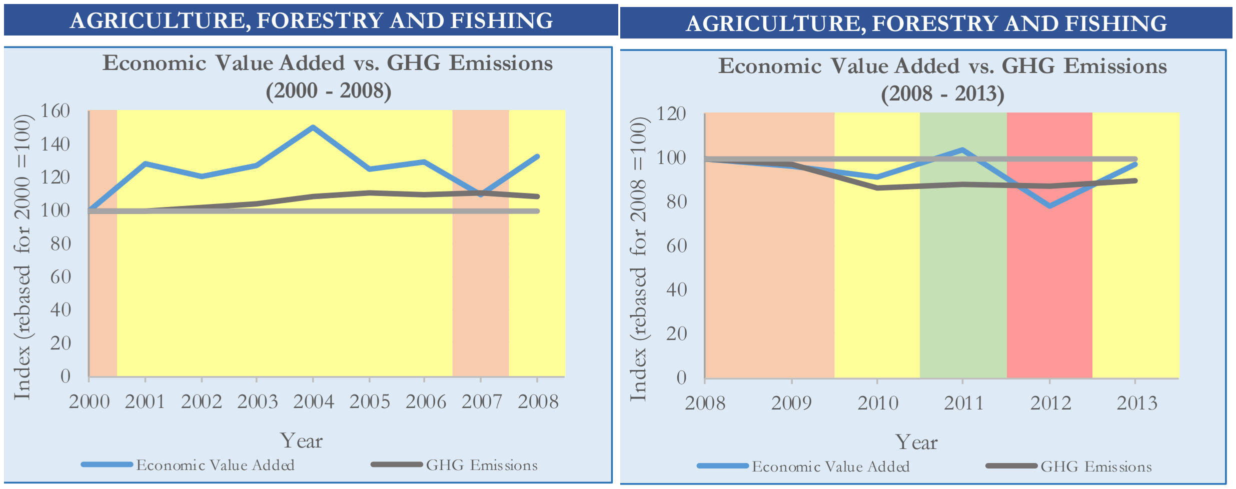


Absolute Decoupling		#N/A	
2000 Intensity Value:	3.35	**2000 Intensity Value:**	30.14
2013 Intensity Value:	2.56	**2013 Intensity Value:**	n.a.
% Intensity Change	-23.7%	**% Intensity Change**	n.a.

Sector-level decoupling can also be considered before and after the 2008 financial crisis, as was presented for macroeconomic indicators. Figure 15 illustrates the decoupling trends in agriculture before and after 2008. Sector level analysis is useful in identifying particular contributions to the aggregate decoupling trend. In the case of the agricultural sector, inconsistent trends in decoupling, especially after 2008, indicate that the sector is not achieving decoupling.

[15] In Figure 14, no data is available for 2013 for the electricity sector, therefore the picture shows “N/A” instead of a decoupling outcome for the figure. This is not a problem, as possible outcomes for 2013 results can be inferred from 2012, or 2012 can be considered as the last year of the analysis.

Figure 15. Romania: Economic Value Added vs. GHG Emissions –Agricultural Sector (2000-2013)



Relative Decoupling	
2000 Intensity Value:	3.35
2008 Intensity Value:	2.75
% Intensity Change	-17.9%

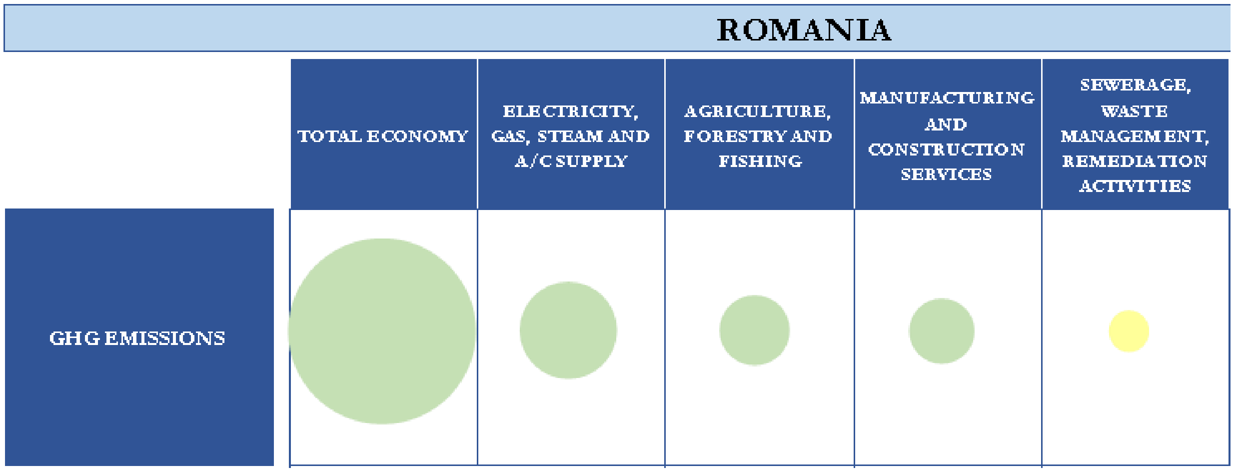
Relative Decoupling	
2008 Intensity Value:	2.75
2013 Intensity Value:	2.56
% Intensity Change	-7.1%

Scorecard Presenting the Externality Share and Decoupling Performance

A "scorecard" of decoupling across sectors offers a way to present a snapshot of the findings of the diagnostic. This scorecard uses circles of various colors and sizes as a visual aid to jointly present the externalities and information on decoupling performance. Circles of different sizes present each sector's share of the total externality. The colors of the circles indicate the economy or individual sector's decoupling performance: green signifies "absolute decoupling," yellow indicates "relative decoupling," orange indicates "no decoupling" and red signifies "negative decoupling." This presentation can reveal which sector causes the largest harm with regard to an externality and how each sector has performed over time relative to its growth trend. With this information in hand, the policymaker can decide on which sector to focus policy measures and limited investment funds to achieve the largest reduction in an externality. It could also help signify where to do more research or do a sector study.

A scorecard for Romania (Figure 16), for example, reveals that in 2012, the electricity sector held the largest share GHG emissions, but displayed an absolute decoupling performance compared to the beginning of the period. By comparison, the waste management sector had a smaller share, but displayed a relative decoupling performance. When using the score card, it is not uncommon to find that sectors have disproportionate contributions to the economy and the environmental externality. For example, in 2012 in Romania, the economic value added by the financial sector was several times higher than that generated by the Electricity, Gas, Waste and Sewage sector, while their contributions to SO_x emissions were reversed.

Figure 16. Romania: Nitrogen Oxide Shares (2012) and Decoupling Outcomes (2000-2012)



Footnotes
Bubble size defined by sector share of total GHG Emissions in 2012
Decoupling evaluated over 2000 - 2012 period

Hypothesizing the Drivers of Decoupling Trends

Examining whether environmental and economic trends decouple provides an approach to measuring Green Growth with the potential to inform and guide policy design and development. For example, the analysis may show that the main drivers behind decoupling are independent of any improvements in the absolute or relative efficiency of environmental input usage in traditional sectors, such as agriculture or manufacturing. Alternatively, the decoupling could be due to the emergence of cleaner sectors (i.e., less energy and natural input intensive sectors) that gradually displace environmentally damaging sectors. Observing the decoupling of economic and environmental trends (or a lack thereof) in a country opens many subsequent questions about why such a pattern exists.

In the case of Romania, the decoupling exercise reveals a country profile where primary sector activities tend to have GHG emissions that follow economic trends, but secondary sectors that have downward trends in emissions despite continued economic growth. Understanding the baseline context of this country's environment and natural resources further illustrates why this occurs. Systematic Country Diagnostics and other background resources can point to specific constraints that direct areas that require further testing or information collection. In Romania, one can posit various scenarios to explain the division between primary and secondary sectors, such as:

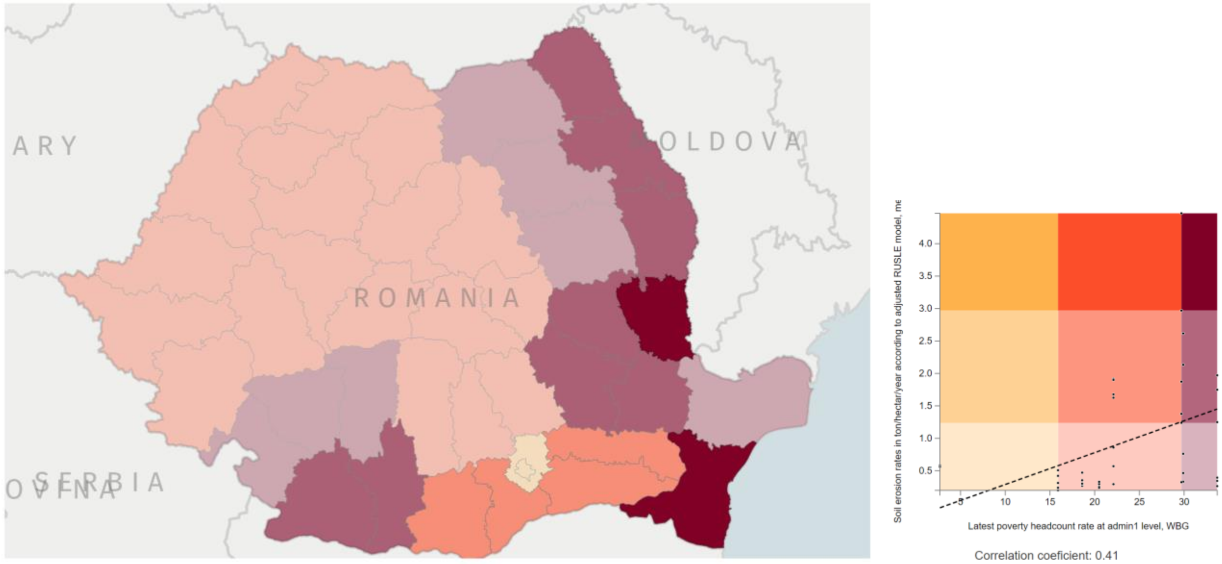
a) Investment in secondary sectors has led to more advanced technology adoption and use, which allows for less environmentally intensive development
b) The primary sector is small or in decline, and therefore has attracted little investment, but also produces relatively low emissions
c) "Dirty" production is being exported, with other countries taking on Romania's burden
d) Accession to the EU directed policy change that shifted practices and standards in the primary and/or secondary sector
e) Rural areas that are more heavily reliant on agricultural activities are gaining the least economically, therefore their economic trend is lower than the secondary sector and results in little extra capital to invest in cleaner technologies

In examining Romania's baseline, we can provide supporting (or negating) evidence for these various hypotheses. In support of Hypothesis *a*, declining pollution damages shown over time in Romania's ANS, coupled with increasing Gross National Saving, suggests that economic development has become less pollution-intensive over time. Hypothesis *b* is supported by the evidence of a declining agricultural sector—since 1990, Romania's agricultural land cover has declined by 4% and agriculture value as a percent of GDP is about one-fifth what it was. The decline of the agricultural sector is likely to have broader economic impacts—it is unlikely that the population reduced food consumption, suggesting that agricultural production may have shifted out of the country, supporting Hypothesis *c*. The major dip in agricultural land was seen in the first decade of the 2000s, when Romania was in the process of EU accession. This could potentially relate to a reclassification of land as protected areas during this time, as a part of the country's Natura declaration. This shift lends credence to Hypothesis *d*, as EU policy would have direct outcomes on natural capital stock. Finally, a decline in the agricultural sector means that more rural areas are impacted economically by this shift, although we cannot say from the evidence presented whether other industries have replaced agriculture in these areas.

Of concern to a declining primary sector is the livelihoods of those impacted. Poverty is mainly a rural issue in Romania, with an average poverty rate of about 24% in rural areas and 3% in urban areas[16]. Diving further into issues of the distribution of wealth, and correlating it with the distribution of environmental impacts, it is clear that issues such as soil erosion and flooding mainly impact poorer areas (see Figure 17 and Figure 18). Relatively poor provinces including Ialomita, Satu Mare and Teleorman are most economically impacted by floods[17] (World Bank, forthcoming). Relatively poor areas such as Braila and Vrnacea are also disproportionately affected[18] by economic damages from earthquakes, even though wealthier provinces such as Bucuresti, Prahova, and Buzau are at greatest risk of earthquakes in terms of absolute GDP losses.

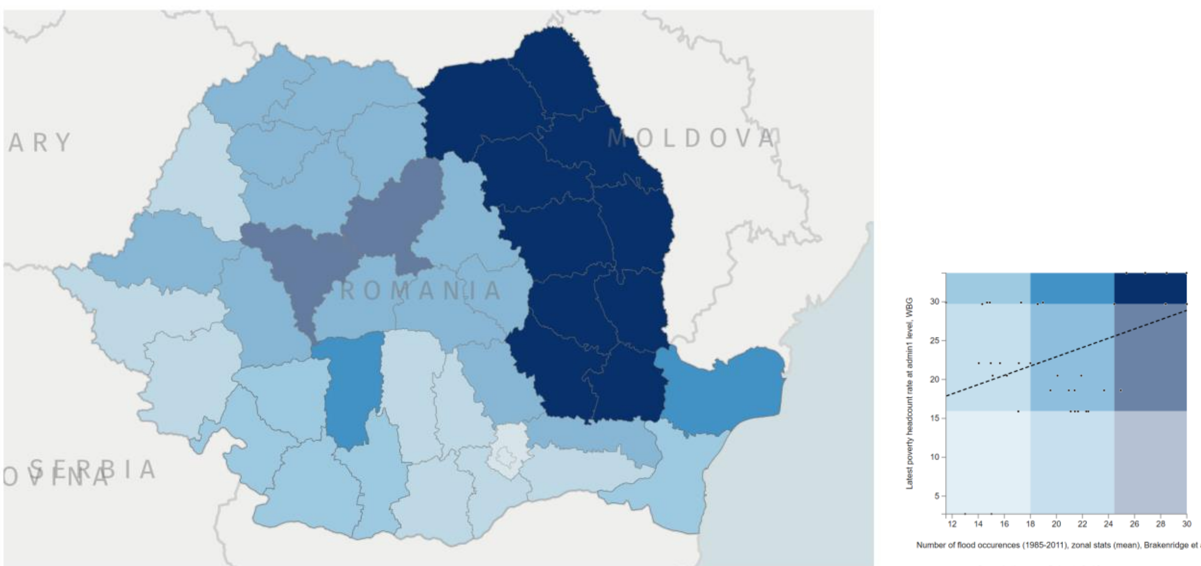
Figure 17: Coincidence of Median Soil Erosion Levels and Poverty in Romania

[16] Based on the Hidden Dimensions of Poverty dataset, figures for 2011 in administrative level 1 (admin-1) units
[17] in terms of normalized annual average of affected GDP
[18] Based on GDP that is normalized (weighted) by inflation and population.



Source: Hidden Dimensions of Poverty dataset, 2018

Figure 18: Coincidence of Number of Flood Events and Poverty in Romania



Source: Hidden Dimensions of Poverty dataset, 2018

Clearly, understanding whether economic and ecological impacts diverge from one another over time is only one step in disentangling the relationships between these two realms. While the decoupling tool presented does not provide causal evidence of influence between environmental and economic trends, it is an important step in that it allows sector-level analysis, which can spur thoughtful development of hypotheses related to underlying causation. One can then design more detailed empirical exercises to test these hypotheses and understand the potential determinants of these linkages.

Policy Implications

Policy interventions that stem from Green Growth measurement should reflect the drivers that influence whether growth is “dirty” or “clean” as much as possible. Rather than only reacting to externalities after they appear, policies should also aim to prevent environmental degradation from occurring. To achieve this, analysis that informs policy must work to reach causal conclusions when possible. In cases where this is not possible, interventions should take into account thoughtful hypotheses for underlying causes and consider potential impacts of intervention. Overall, policies should work to reduce environmental degradation while promoting shared prosperity through poverty reduction measures.

The decoupling exercise for Romania, for example, revealed a divergence in the way that primary and secondary sector activities relate to economic growth. Through these findings, and informed by a variety of baseline measures, a set of hypotheses was developed that builds a cohesive story for Romania’s intertwined environmental and economic paths, which is ready for further analysis.

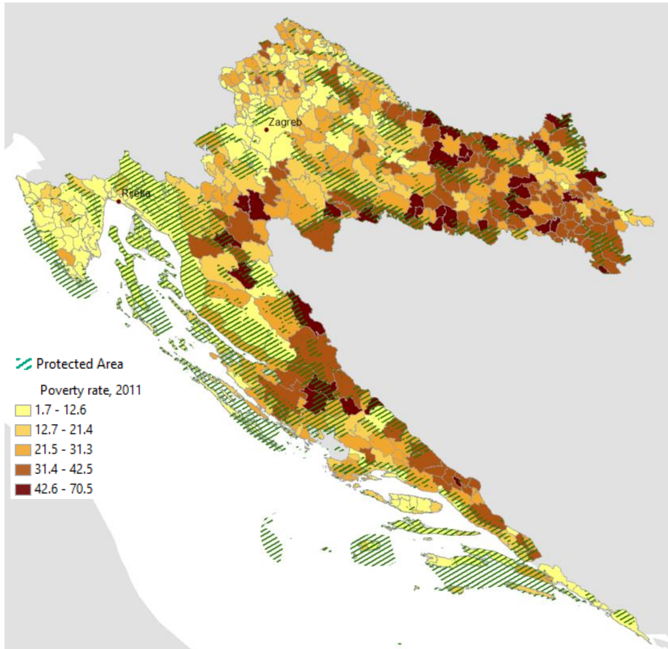
Given the observed trends in this analysis, there is promise for continued investment in secondary sectors to promote the use of clean technology, and that allows for less degradation-intensive development. Promoting such investment may be sought through policy levers that incentivize the adoption of modern technology, and/or through penalties for the generation of pollutants and other environmental degradation.

Support for the secondary sector should not allow for neglect of the primary sector, however. Despite declining in economic power in recent decades, agriculturally dependent rural areas should be supported through pro-poor measures that encourage clean and efficient farming methods, such that decoupling may occur in this sector in the future. Furthermore, other environment-focused economic opportunities such as eco-tourism can be encouraged in rural areas with rich natural resources to encourage green income opportunities.

A potential policy implication of these findings could be that “dirty” production is being exported. If that is the case, one can question the value of these decoupling gains, because they are effectively equivalent to a transfer of “dirty” sectors to other countries and do not constitute evidence of real and sustainable green growth. As EU accession appears to have influenced Romania’s protected area policies, this body may be an effective regulator of exporting environmental degradation, not only for Romania, but for other member states as well. International-level decisionmakers should also take a lead in highlighting the problematic exportation of environmental externalities globally.

The example of Romania may not necessarily apply to other countries. Croatia, for example, has a large tourist industry that benefits from protected areas. Subnational patterns in economic and environmental patterns can be observed through the coincidence of poverty and protected areas (Figure 19; World Bank 2017b). Analysis of the tourism sector therefore offers a key opportunity for intervention to encourage the decoupling of economic growth and environmental degradation, as the benefits of tourism need to be balanced with the ecosystem’s carrying capacity.

Figure 19. Income-based poverty rate and protected areas in Croatia



Source: Hidden Dimensions of Poverty Dataset, 2018
Note: Protected area (%) is the percent of a district that is part of a protected area

A Way Forward: Data, Methods and Tools

Information on imports, in addition to domestic production, could be used to test if the decoupling gains are robust to additional sources of distortion. The investigation could be augmented by considering other cross countries characteristics such as the income level, energy mix and/or industrial organization. This provides evidence that the insights offered by the decoupling analysis could generate tangible policy implications.

Further data on jobs and household consumption can also help inform these policy recommendations through more disaggregated analysis. Countries and international bodies can support this work through the publication of business registers and nationally and sub-nationally representative household surveys.

One example of a deeper dive into the relationship between economic growth and rural livelihoods is through the systematic surveying of households using the Living Standard and Measurement Surveys (LSMS).[19] These surveys elicit information on a household demographics, income, expenditure, and assets in order to support evidence-based policymaking.

Recently, the LSMS has been modified to entail environmental indicators, including through a Forestry Module, developed to look at the role of forests in rural livelihoods.[20] Several interesting policy questions can be informed from the application of these surveys: 1) do poor households have a greater reliance on forest resources? 2) do forests represent an economic opportunity for households? 3) can forest resource use for economic benefits sustain a reduction in poverty without forest degradation? (PROFOR 2017).

[19] Additional LSMS modules cover specific topics including agriculture and forestry. Further information on the LSMS surveys can be found at http://go.worldbank.org/IFS9WG7EO0.
[20] Forestry module information can be found at http://www.fao.org/forestry/forestry-modules/en/.

One recent application of the Forest LSMS investigated the role of forests in the livelihoods of Turkish Forest Villagers, where findings indicated that forests represented the greatest share of income among the lowest income quintile and that the greater the share of forests in income, the greater was the propensity to migrate to other areas in seeking better opportunities (PROFOR 2017). These findings suggest that social protection and local economic development programs should focus on the poorest areas, where forest dependence is greatest. In addition, the survey provided evidence that the timber supply value chain should be strengthened and be more inclusive in poorer villages.

Through fine-scale, detailed data such as LSMS, Green Growth analyses can move toward understanding causal relationships between economic growth and environmental impacts, which a decoupling analysis does not provide on its own. Thus, the Green Growth Decoupling Tool provides an important stage in a multi-step process, with understanding underlying causes of environmental degradation related to development as a main goal.

Conclusions

Currently, there is a push toward understanding, promoting, and achieving Green Growth as a greater goal. New methodological tools can provide insight into both progress and shortcomings of Green Growth. By providing empirical evidence to identify levels of decoupling, we aim to raise the level of discourse surrounding cleaner development. The decoupling tool presented here offers a way to assess the relationship between economic growth and ecological impacts in a way that allows country and sector-specific tailoring. The flexibility of this tool is one of its major strengths, avoiding the trap of over-simplification that can result from a one-size-fits-all approach.

To deploy Green Growth tools for policy action, certain data needs must be met, and a process through which to analyze Green Growth must be adopted. The decoupling exercise presented here offers an actionable tool with which researchers and policymakers may better understand the consequences of "dirty" development and the benefits of growing more cleanly. The adoption of such a tool will also require a willingness from lawmakers to take action that captures necessary data and supports the use of it in a thoughtful way. First actions toward the adoption of this tool should identify data needs related to surveying and economic and environmental monitoring to ensure that inputs are valid, precise, and representative.

By adopting a common global framework for Green Growth measurement, policymakers will be better able to benchmark achievements and shortcomings related to national policies and international agendas such as the Sustainable Development Goals and the Paris Climate Agreement. Internally within international organizations, Green Growth initiatives can draw upon the work of items like Systematic Country Diagnostic exercises and prove useful in bolstering these to promote cleaner development paths. Sharing these analyses with partner countries and organizations can additionally help in assessing their own growth.

In order to achieve the ambitious goal of Green Growth, this concept must be measurable. Too often, Green Growth is preached, yet policy falls short on taking action, not for lack of political willpower, but for lack of understanding of where a country stands and what should be considered as metrics of success. The Green Growth Decoupling Tool presented here offers an opportunity to measure success and work toward improving environmental impacts of development.

References

Baldé, K., and K. Baas. 2013. “Green Growth in the Netherlands 2012.” The Hague: Statistics Netherlands. http://library.wur.nl/WebQuery/hydrotheek/2043020.

Belli, Pedro, Jock R. Anderson, Howard N. Barnum, John A. Dixon, and Jee-Peng Tan. 2001. “Economic Analysis of Investment Operations Analytical Tools and Practical Applications.” 29821. Washington, D.C.: World Bank. http://documents.worldbank.org/curated/en/792771468323717830/Economic-analysis-of-investment-operations-analytical-tools-and-practical-applications.

Green Growth Knowledge Platform. 2013. “Moving towards a Common Approach on Green Growth Indicators.” Global Green Growth Institute, OECD, UNEP and The World Bank.

Lange, Glenn-Marie, Quentin Wodon, and Kevin Carey, eds. 2018. *The Changing Wealth of Nations 2018: Building a Sustainable Future*. Washington, D.C.: World Bank.

OECD. 2011. “Towards Green Growth: Monitoring Progress: OECD Indicators.” OECD Green Growth Studies. OECD Publishing.

PROFOR. 2017. “Poverty, Forest Dependence and Migration in the Forest Communities of Turkey: Evidence and Policy Impact Analysis.” Washington, D.C.: World Bank.

UNEP. 2011a. “Decoupling Natural Resource Use and Environmental Impacts from Economic Growth.” A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., Swilling, M.von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A.

———. 2011b. “Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers.” www.unep.org/greeneconomy.

World Bank. Forthcoming. “Romania Systematic Country Diagnostic.” Washington, D.C.

———. 2012. *Inclusive Green Growth : The Pathway to Sustainable Development*. Washington, DC. https://openknowledge.worldbank.org/handle/10986/6058.

———. 2016a. “Green Growth in Latin America: Colombia. Phase 1 Diagnostic Results and Observations.”

———. 2016b. “Green Growth in the European Union: Bulgaria. Phase 1 Diagnostic Results and Observations.” Powerpoint.

———. 2016c. “Green Growth in the European Union: Croatia. Phase 1 Diagnostic Results and Observations.”

———. 2016d. “Green Growth in the European Union: Romania. Phase 1 Diagnostic Results and Observations.”

———. 2016e. “Green Growth in the Russian Federation. Phase 1 Diagnostic Results and Observations.”

———. 2017a. “Poland: Toward a Strategic, Effective, and Accountable State Systematic Country Diagnostic.” Washington, D.C.

———. 2017b. “The Republic of Croatia Systematic Country Diagnostic.” Washington, D.C.

———. 2018. “World Development Indicators [Data].” 2018. http://data.worldbank.org/indicator/EN.ATM.CO2E.KT.

Appendix 1. Definitions of Economic and Green Growth Indicators

Macroeconomic indicators

Economic indicator definitions are based on the World Development Indicators (World Bank 2018).

GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.

Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement.

Household final consumption expenditure (formerly private consumption) is the market value of all goods and services, including durable products (such as cars, washing machines, and home computers), purchased by households. It excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. It also includes payments and fees to governments to obtain permits and licenses. Here, household consumption expenditure includes the expenditures of nonprofit institutions serving households, even when reported separately by the country.

General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.

Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.

Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.

Gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

Sectoral Indicators

Sectoral indicators come from Eurostat, and are defined from this database.

Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.

Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.

Services correspond to ISIC divisions 50-99. They include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

Appendix 2. Expanded Explanation of Decoupling Types

In practice, the analysis begins by choosing a threshold level to differentiate between the types of decoupling (i.e. absolute, relative, negative and no decoupling). Below, a 5% rule is used and illustrated, but there could be others and it is up to the analyst to decide the value of the threshold that is appropriate for the problem investigated. Specifically, the various decoupling measures are calculated as follows.

Absolute decoupling occurs if the rebased[21] environmental externality is lower or equal to 95% of the rebased economic indicator. For example, in Romania, the rebased GHG emissions indicator in 2010 was 83.40 compared to the base year in 2000 (=100), while the rebased GDP indicator was 152.75 compared to the base year in 2000 (=100). Since GHG emissions decreased (i.e., 83.40 < 100), and GDP increased (i.e., 152.75 > 100), and GHG emissions in 2010 are below 95% of GDP in 2010 (i.e. 83.40 is around 55% of 152.75), GHG emissions are said to be absolutely decoupled from GDP.

No decoupling occurs when the rebased environmental externality is greater than or equal to 95% of the rebased economic indicator, but lower than or equal to 105% of the rebased economic indicator. For example, in Romania in 2001, rebased GHG emissions was 103.21, while rebased GDP was 105.59. Thus, no decoupling occurs between GHG emissions and GDP because GHG emissions represent 98% of GDP, which is above 95%, but below 105%.

Negative decoupling occurs when the rebased environmental externality is greater than 105% of the rebased economic indicator. For example, in Romania in 2007, rebased water abstraction in agriculture was 116.91, while rebased Economic Added Value (EVA) of the sector was 109.79. Since water abstraction is around 106% of the EVA for that year, the indicators are considered negatively decoupled.

Finally, relative decoupling encompasses all the remaining possibilities. For example, Romanian rebased GHG emissions in 2006 were 105.33, while the GDP was 142.95. Because GHG emissions are greater than the base year level (i.e. 105.33 > 100), absolute decoupling is not possible. Furthermore, GHG emissions in 2007 are less than 95% of GDP (i.e. 105.33 is approximately 73% of 142.95), thus ``no decoupling'' is not possible. Also, negative decoupling is excluded because the rebased GHG emissions indicator is lower than the rebased GDP indicator (i.e., 105.33 < 142.95). Thus for 2007, GHG emissions were relatively decoupled from GDP.

[21] A “rebased” indicator, whether environmental or economic, is an index number expressed as 100 times the ratio between the current year indicator and the base year indicator. For example, the GHG emissions in Romania were 141,142 thousand tons in 2000, and 117,706 thousand tons in 2010. If the base year is taken to be the year 2000, then the rebased indicator in 2000 is 100, and the rebased GHG indicator in 2010 is 83.40.

Appendix 3. Comparison between Decoupling Measures and Intensity Approach

The purpose of this Appendix is to provide a comparison between various decoupling measures (i.e., absolute, relative, negative and no decoupling) and the intensity approach introduced above. Fundamentally, the decoupling measures and the intensity approach provide the same information, but in a slightly different form.

Before proceeding, some preliminary notation is required. The building blocks of both concepts are the economic indicators (i.e., GDP, Economic Value Added, Employment, etc.) and environmental indicators (i.e., greenhouse gas emissions, SO_x , NO_x , PM_x, etc.). Denote the economic indicator in the base year and the economic indicator in any year following the base year as E_b and E_t, respectively. Clearly, $t \geq b$. Similarly, denote the pollutant (i.e., environmental indicator) by P_b and P_t, respectively.

By definition, the intensity at time t, I_t, is calculated as:

$$I_t = \frac{P_t}{E_t}$$

and the change in the intensity is:

$$\frac{I_t - I_b}{I_b} = \frac{I_t}{I_b} - 1 = \frac{\frac{P_t}{E_t}}{\frac{P_b}{E_b}} - 1 = \frac{\frac{P_t}{P_b}}{\frac{E_t}{E_b}} - 1 = \frac{B}{A} - 1$$

Where B and A represent the rebased environmental indicator and the rebased economic indicator, respectively. The notation B and A was chosen to be consistent with the notation used in the Excel Decoupling Tool. The various types of decoupling are defined in terms of the values B/A takes within certain intervals. For example, absolute decoupling is defined by the following three conditions: 1) if $\frac{B}{A} \leq$ 95% (i.e. $B \leq 95\%A$), 2) $P_t < P_b$, and 3) $E_t > E_b$. Thus, both approaches (i.e., decoupling and intensity) present the same information regarding economic and environmental trends, albeit in different formats.