

The Regional Impacts of the 2008-2009 Global Economic Crisis on Ecosystem Vitality

H. D. Kaya¹

¹College of Business and Technology, Northeastern State University,
3100 E. New Orleans St., Broken Arrow, Oklahoma (United States);
Email : kaya@nsuok.edu

ABSTRACT

In this study, we examine the regional impacts of the 2008-2009 global economic crisis on Ecosystem Vitality. We also examine the impacts on Ecosystem Vitality's seven components which include Air Pollution (on ecosystem), Water (on ecosystem), Biodiversity and Habitat, Agriculture, Forestry, Fisheries, and Climate Change, and also on their 17 subcomponents. We examine the impacts in six regions of the world: the Americas, Asia and Pacific, Eastern Europe and Central Asia, Europe, Middle East and North Africa, and Subsaharan Africa. We find that the "Ecosystem Vitality" indicator significantly deteriorated in three regions: the Americas, Eastern Europe and Central Asia, and Europe. In the other three regions, the deterioration is not statistically significant. When we examine the components and the subcomponents, we find that, in the Americas, the Water (on ecosystem), the Climate Change and the Fisheries indicators worsened but the Forestry indicator improved. In Eastern Europe and Central Asia, the impact on Biodiversity and Habitat, Fisheries and Climate Change were significantly negative, but Air Pollution (on ecosystem) improved. In Europe, the impact on Biodiversity and Habitat and Climate Change were significantly negative, but Air Pollution (on ecosystem) and Forestry improved. In the other three regions, very few components were affected.

Keywords: Global crisis, environment, sustainability, ecosystem.

Mathematics Subject Classification: 62G10

Journal of Economic Literature (JEL) Classification : Q50, Q53, Q54, Q56, Q57, Q58

1. INTRODUCTION

This study examines the regional impacts of the 2008-2009 global economic crisis on ecosystem vitality. The impact on ecosystem vitality is examined in the Subsaharan Africa, North Africa, Eastern Europe and Central Asia, Americas, Asia and Pacific, Europe, Middle East. The indicators that are examined are the seven main components of ecosystem vitality which are Air Pollution (on ecosystem), Water (on ecosystem), Biodiversity and Habitat, Agriculture, Forestry, Fisheries, and Climate Change, and their 17 subcomponents.

There is a debate on the relationship between economic development (or income) and environmental quality. Some of the previous studies like Selden and Song (1994), Grossman (1995), Stern et al. (1996), Bartz and Kelly (2008), and Galeotti (2007) argue that there is an inverted U-shaped relationship between economic development and environmental quality. For lower incomes, more

economic development brings in environmental degradation, while for higher incomes, more economic development increases environmental quality. Several other studies like Lopez (1994), Broad (1994), Smulders (1995), and Spangenberg et al. (2002) argue that, under certain conditions, both environmental quality and economic development can be achieved. Ekins (1997) and Dasgupta et al. (2006) are more pessimistic about the relationship between economic development and the environment.

There are a few studies that are more inconclusive like Scruggs (1998), Van den Bergh (2011), and Brock and Taylor (2005). More recently, Sokolov et al. (2019) examine Ukraine and suggests that policymakers to modify the country's investment and innovation management policies. Fotourehchi and Ebrahimpour (2019) show that both degrading environmental capitals and improving human capitals positively affect economic growth in developing countries. They suggest that investments in health is more beneficial to growth than investing in environment or education. Da Silva, Vieira, and Saiani (2019) show that economic development increases pollution in Brazil, India, China, and South Africa. They also show that the Environmental Kuznets Curve Hypothesis does not hold for Brazil and India.

In this study, we contribute to this debate by examining the relationship between income and several aspects of ecosystem vitality in 132 countries. We examine how a global macroeconomic event, namely the 2008-2009 global economic crisis, affects ecosystem vitality around the world through its impact on incomes. We compare pre- and post crisis indicator values for each region. We take the 2007 values as our pre-crisis values, and the 2010 values as our post-crisis values.

Our findings will show the ecosystem vitality categories that were affected more negatively in each region when the global crisis hit. Policymakers will be able to use these findings to devise strategies that would protect those certain aspects of their country's or region's ecosystem.

The layout of the paper is as follows: Section 2 shows our hypotheses. Section 3 explains our data and methodology. Section 4 shows the results. Section 5 concludes.

2. HYPOTHESES

Due to budgetary issues, during an economic crisis, we expect governments to focus less on ecosystem vitality issues. Therefore we expect to see these indicators to deteriorate during an economic crisis. Our first hypothesis is as follows:

Hypothesis 1: In each region, the ecosystem vitality indicator declines after an economic/financial crisis.

Similarly, in each region, we expect to see deterioration in all seven components of ecosystem vitality. Therefore, the next seven hypotheses deal with these components:

Hypothesis 2: In each region, the Air Pollution (on ecosystem) indicator and all of its subcomponents decline after an economic crisis.

Hypothesis 3: In each region, the Water (on ecosystem) indicator and all of its subcomponents decline after an economic crisis.

Hypothesis 4: In each region, the Biodiversity and Habitat indicator and all of its subcomponents decline after an economic crisis.

Hypothesis 5: In each region, the Agriculture indicator and all of its subcomponents decline after an economic crisis.

Hypothesis 6: In each region, the Forestry indicator and all of its subcomponents decline after an economic crisis.

Hypothesis 7: In each region, the Fisheries indicator and all of its subcomponents decline after an economic crisis.

Hypothesis 8: In each region, the Climate Change indicator and all of its subcomponents decline after an economic crisis.

The next section explains our data and methodology.

3. DATA AND METHODOLOGY

We are using a dataset created by Yale University and Columbia University in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission ((available at <http://epi/yale.edu> and distributed by the NASA Socioeconomic Data and Applications Center at <http://sedac.ciesin.columbia.edu/data/set/epi-environmental-performance-index-pilot-trend-2012>). The dataset covers 132 countries. Table 1 shows the regions and the countries included in the dataset.

The dataset lists the Environmental Performance Index (i.e. EPI) which was computed from several components and subcomponents. The EPI Index has two main components: “Environmental Health” and “Ecosystem Vitality”. Each of these two main components have several subcomponents. This current study deals with Ecosystem Vitality (i.e. EV). Therefore, we use the data on EV, its seven components (which are Air Pollution (on ecosystem), Water (on ecosystem), Biodiversity and Habitat, Agriculture, Forestry, Fisheries, and Climate Change), and their 17 subcomponents (which are listed on Tables 2 through 7).

Table 1. Countries in Each Region

Americas

Argentina, Bolivia, Canada, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, USA, Uruguay, Venezuela

Asia and Pacific

Australia, Bangladesh, Brunei, Cambodia, China, India, Indonesia, Japan, Malaysia, Mongolia, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand, Viet Nam

Eastern Europe and Central Asia

Albania, Armenia, Azerbaijan, Belarus, Bosnia, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Russia, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan

Europe

Austria, Belgium, Bulgaria, Cyprus, Czech Rep., Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK

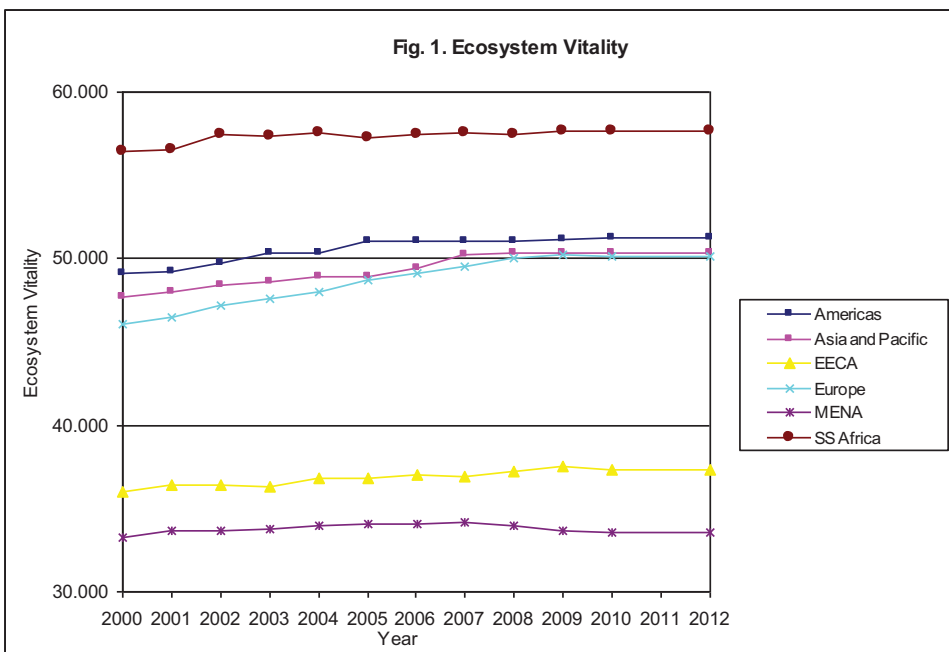
Middle East and North Africa

Algeria, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, UAE, Yemen

Sub-Saharan Africa

Angola, Benin, Botswana, Cameroon, Congo, Cote D'Ivoire, Dem. Rep. of Congo, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Mozambique, Namibia, Nigeria, Senegal, South Africa, Tanzania, Togo, Zambia, Zimbabwe

Figure 1 shows the trend in EV over time. We are seeing that the trend is positive (i.e. improvement) for all regions until 2007. After 2007, most regions seem to be flat while EECA region continues with a slight improvement and MENA region continues with a slight decline.



Figures 2 through 8 show the trends in the seven components of EV over time. Figure 2 shows the trend in Air Pollution (on ecosystem). We are seeing that the trend is positive (i.e. improvement) for all regions until 2005. After 2005, all regions seem to be flat.

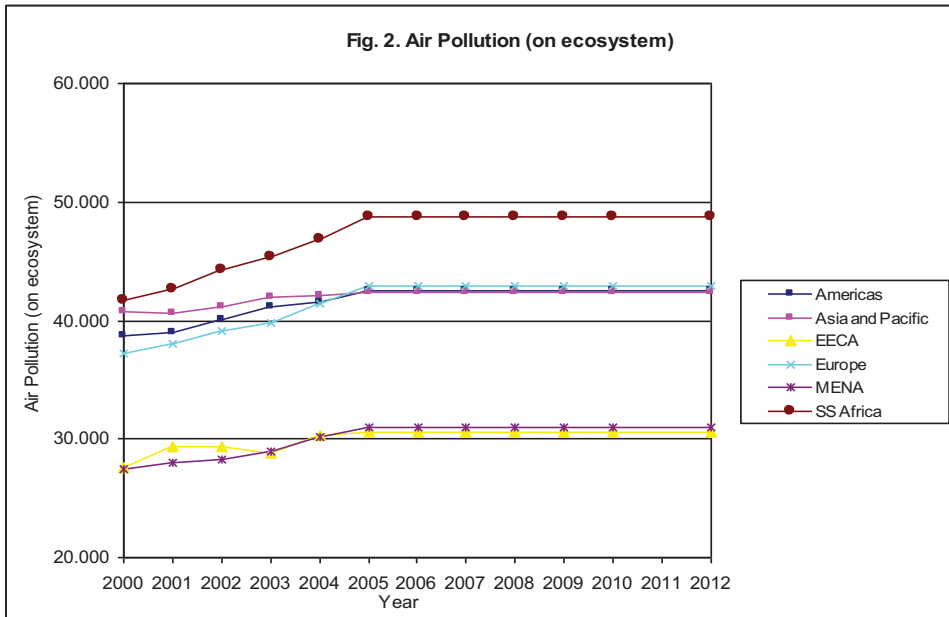


Figure 3 shows the trend in Water (on ecosystem). We are seeing that the trend is almost flat throughout the whole period (i.e. from year 2000 to 2012).

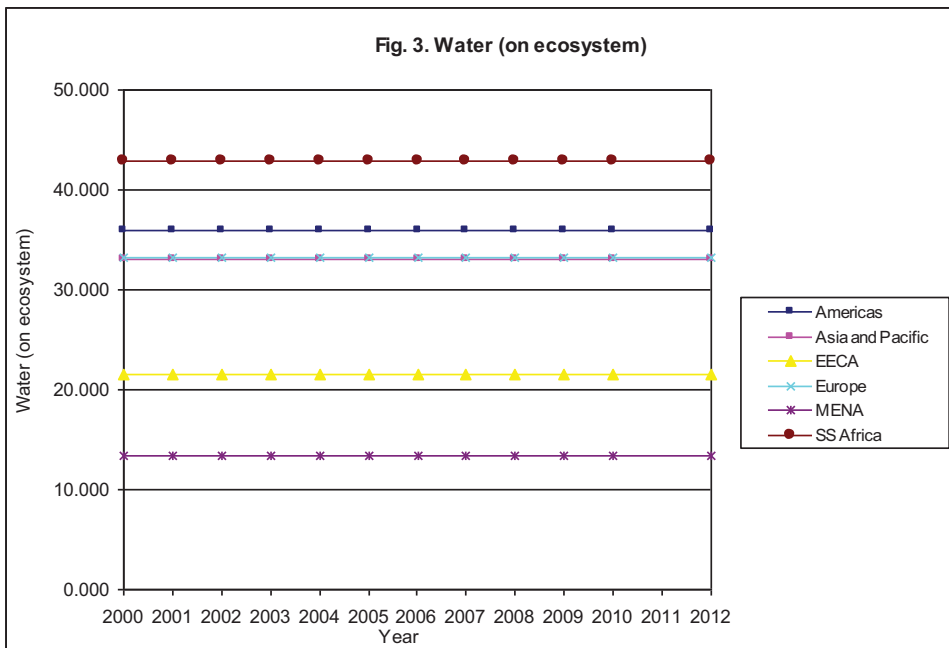


Figure 4 shows the trend in Biodiversity and Habitat. MENA region was almost flat since 2003. The Americas became flat in 2005. Asia and Pacific seems to be flat after 2007. All other regions continued their improvements even after 2007.

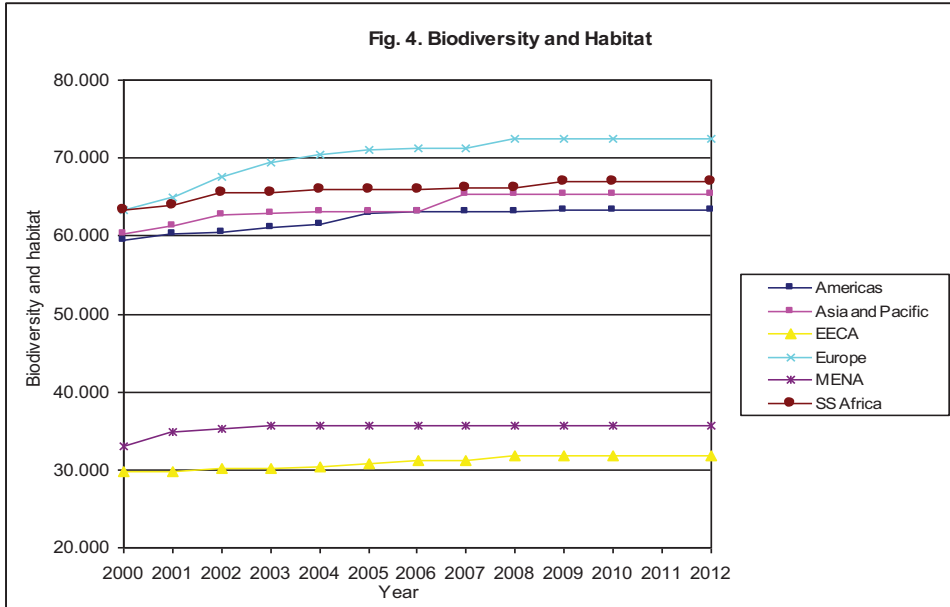


Figure 5 shows the trend in Agriculture. There were big improvements in Asia and Pacific and Europe between 2004 and 2007, and there were big declines in Sub-Saharan Africa and EECA region until 2005. For most regions (except for Europe), after 2005, the trend was flat. For Europe, the trend became flat after 2007.

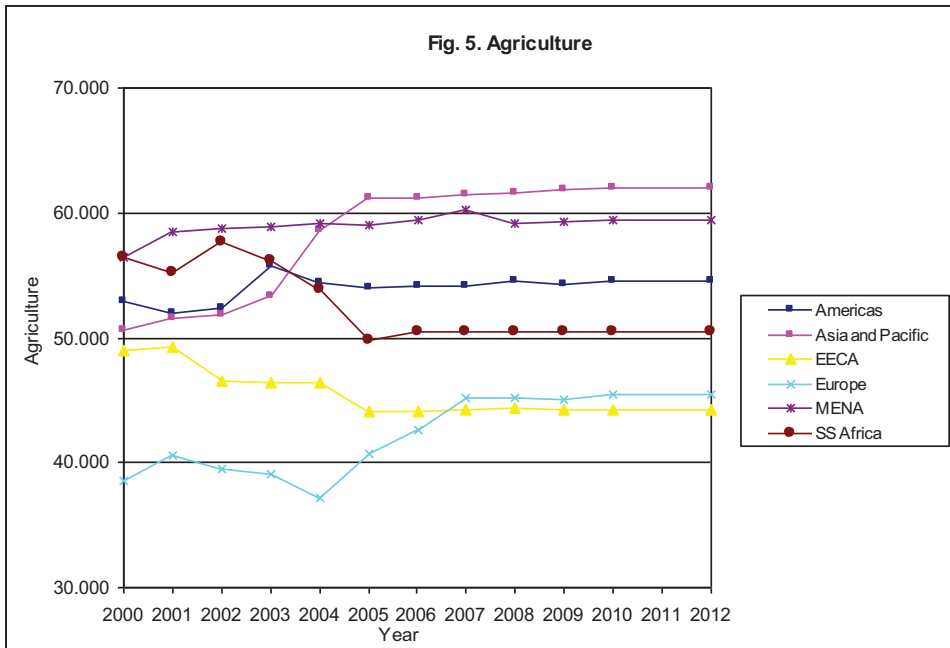


Figure 6 shows the trend in Forestry. EECA region and Europe were mostly flat until 2008. After 2008, they declined. The other regions improved until 2007 or 2008. After that, some regions were flat, some declined.

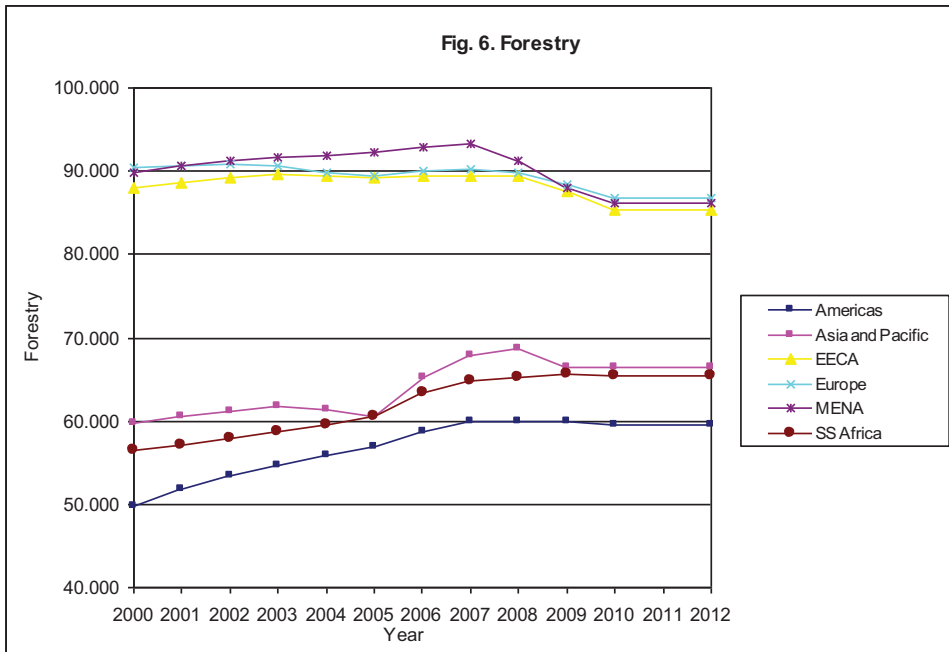


Figure 7 shows the trend in Fisheries. MENA region declined until 2006. After that, it was flat. All other regions were mostly flat throughout the whole period.

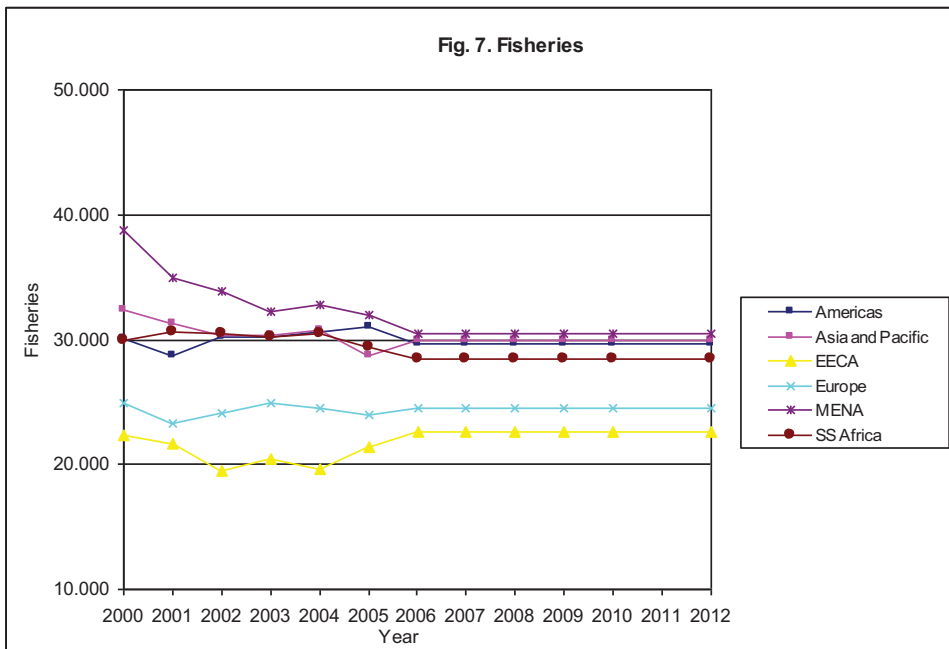
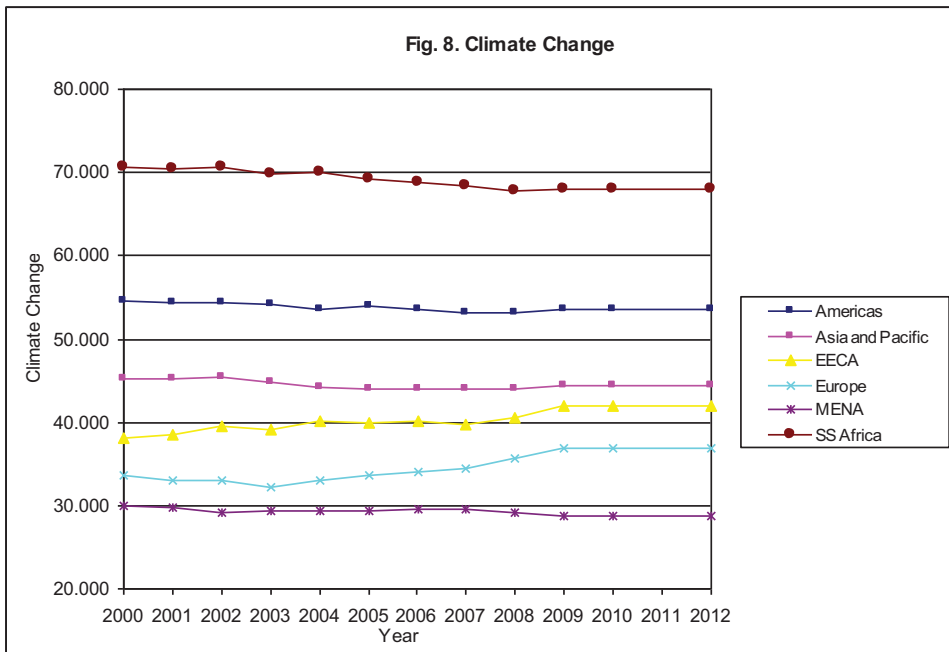


Figure 8 shows the trend in Climate Change. Most regions declined (although some declined slightly) throughout the period. EECA region and Europe actually improved in this measure.



In the next section, we will use non-parametric tests (Mann-Whitney-Wilcoxon tests) to compare the pre-crisis period to the post-crisis period. We take the year 2007 values as our pre-crisis values and the year 2010 values as our post-crisis values. We will compare the percentage change in each indicator during year 2007 to the corresponding change during year 2010.

4. EMPIRICAL RESULTS

Table 2 compares the percentage change in Ecosystem Vitality (EV) in the Americas pre- and post-crisis. It also compares the percentage change in the components and subcomponents of EV pre- and post-crisis. The results of the Mann-Whitney-Wilcoxon tests are shown in the last column.

We are seeing that pre-crisis (i.e. 2007), the mean annual percentage change in EV was 0.128%. Post-crisis (i.e. 2010), this number is only 0.000% (i.e. flat). This is a statistically significant drop ($p=0.0069$). EV was improving by 0.128% in annual terms pre-crisis. This improvement fully disappeared post-crisis.

When we look into the seven main components of EV, we are seeing that two of them (i.e. Water (on ecosystem) and Climate Change) worsened, while one of them (i.e. Forestry) improved. Water (on ecosystem) was flat (i.e. 0.000%) in 2007, when compared to the previous year. This annual change percentage dropped to -0.002% in 2010 (i.e. the 2010 value was 0.002% lower, on average, than the previous year). This change was statistically significant ($p=0.0042$). Climate Change was improving by 2.423% annually in 2007. This number dropped to 0.049% in 2010. This change was significant

($p=0.0096$). On the other hand, Forestry was declining (i.e. -0.678%) in 2007. It improved to 0.004% in 2010. This change is positive and significant ($p=0.0051$). The other four main components of EV (i.e. Air Pollution (on ecosystem), Biodiversity and Habitat, Agriculture, and Fisheries) did not change significantly.

Table 2. The Impact of the Global Crisis on Ecosystem Vitality in Americas

Variables	Before			After			Wilcox.
	Mean	Median	Std.	Mean	Median	Std.	p-value
Ecosystem Vitality	0.128	0.276	1.517	0.000	0.001	0.006	0.0069
Air Pollution (on ecosys.)	0.000	0.000	0.000	-0.002	0.002	0.012	0.1476
Water (on ecosystem)	0.000	0.000	0.000	-0.002	-0.003	0.009	0.0042
Biodiversity and Habitat	0.194	0.000	0.490	0.000	0.000	0.005	0.1330
Agriculture	0.822	0.000	2.331	-0.001	0.000	0.005	0.2060
Forestry	-0.678	-0.005	3.691	0.004	0.005	0.008	0.0051
Fisheries	0.000	0.000	0.000	-0.001	-0.001	0.011	0.1375
Climate Change	2.423	0.988	10.2	0.049	0.003	0.235	0.0096
SO2 emissions per capita	0.000	0.000	0.000	-0.004	-0.001	0.011	0.3022
SO2 emissions per GDP	0.000	0.000	0.000	0.003	0.001	0.012	0.3022
Change in water quantity	0.000	0.000	0.000	-0.002	-0.003	0.009	0.0042
Biome protection	3.083	0.000	13.2	0.008	0.001	0.053	0.3221
Marine protection	0.147	0.000	0.645	0.001	0.001	0.004	0.3303
Critical habitat protection	0.154	0.000	0.672	0.005	0.001	0.020	0.1399
Agricultural subsidies	1.993	0.000	5.479	-0.001	0.000	0.007	0.0238
Pesticide regulation	0.000	0.000	0.000	0.000	-0.004	0.008	0.3892
Growing stock change	-4.490	0.000	21.4	0.001	0.000	0.003	0.0741
Forest loss	0.000	0.000	0.000	-0.001	-0.001	0.007	0.1427
Forest cover change	-1.525	-0.122	4.009	0.010	0.000	0.052	0.0038
Fishing stocks overexp.	0.000	0.000	0.000	-0.002	0.001	0.019	0.3950
Coastal shelf fishing pres.	0.000	0.000	0.000	0.002	0.000	0.015	0.3940
CO2 per capita	7.500	0.000	32.8	-0.002	0.000	0.010	0.2817
CO2 per GDP	1.877	2.024	4.195	0.001	0.003	0.007	0.0021
CO2 emis. per elec. gen.	0.764	3.960	27.9	-0.010	0.000	0.049	0.0416
Renewable electricity	4.104	3.322	14.0	0.000	0.000	0.000	0.0017

When we look at the 17 subcomponents, we are seeing that five of them worsened and two of them improved, while the remaining ones did not change significantly. Change in water quantity, Agricultural subsidies, CO2 per GDP, CO2 emission per electricity generated, and Renewable electricity declined. On the other hand, Growing stock change and Forest cover change improved.

Table 3 compares the percentage change in Ecosystem Vitality (EV) in Asia and Pacific pre- and post-crisis. We are seeing that pre-crisis (i.e. 2007), the mean annual percentage change in EV was

0.207%. Post-crisis (i.e. 2010), this number is -0.001% (i.e. flat). However, this is not a statistically significant drop ($p=0.2900$).

Table 3. The Impact of the Global Crisis on Ecosystem Vitality in Asia and Pacific

Variables	Before			After			Wilcox.
	Mean	Median	Std.	Mean	Median	Std.	p-value
Ecosystem Vitality	0.207	0.111	0.856	-0.001	-0.001	0.006	0.2900
Air Pollution (on ecosys.)	0.000	0.000	0.000	0.002	-0.002	0.009	0.3940
Water (on ecosystem)	0.000	0.000	0.000	0.005	0.004	0.021	0.2023
Biodiversity and Habitat	0.019	0.000	0.064	0.001	0.000	0.007	0.1473
Agriculture	0.777	0.000	2.968	-0.001	0.001	0.006	0.3774
Forestry	0.667	0.000	8.513	0.000	0.000	0.007	0.2978
Fisheries	0.000	0.000	0.000	-0.004	-0.004	0.012	0.0197
Climate Change	-0.373	-0.296	4.011	0.004	0.002	0.015	0.2730
SO2 emissions per capita	0.000	0.000	0.000	0.001	0.003	0.009	0.0427
SO2 emissions per GDP	0.000	0.000	0.000	0.003	0.004	0.012	0.0810
Change in water quantity	0.000	0.000	0.000	0.005	0.004	0.021	0.2023
Biome protection	0.008	0.000	0.025	-0.001	0.000	0.011	0.3811
Marine protection	0.018	0.000	0.068	0.001	0.003	0.004	0.1060
Critical habitat protection	0.058	0.000	0.193	0.018	0.005	0.054	0.2674
Agricultural subsidies	50.591	0.000	229.1	0.005	0.000	0.014	0.3575
Pesticide regulation	0.000	0.000	0.000	-0.001	-0.004	0.005	0.2659
Growing stock change	-2.166	0.000	29.0	-0.008	0.000	0.031	0.1519
Forest loss	1.620	0.000	7.426	0.000	0.001	0.008	0.1445
Forest cover change	0.522	0.000	13.3	-0.003	0.000	0.011	0.1700
Fishing stocks overexp.	0.000	0.000	0.000	-0.001	0.000	0.009	0.5000
Coastal shelf fishing pres.	0.000	0.000	0.000	0.003	-0.004	0.038	0.2662
CO2 per capita	-1.806	0.000	9.062	0.004	0.000	0.022	0.0399
CO2 per GDP	0.354	0.341	3.515	0.001	0.002	0.005	0.0405
CO2 emis. per elec. gen.	-5.433	0.417	26.3	0.027	0.030	0.355	0.4056
Renewable electricity	2.491	1.067	9.591	0.000	0.000	0.000	0.2795

When we look into the seven main components of EV, we are seeing that only Fisheries indicator was affected significantly. Fisheries was flat (i.e. 0.000%) in 2007. It was -0.004% in 2010. This change is statistically significant ($p=0.0197$). None of the other six main components of EV changed significantly.

When we look at the 17 subcomponents, we are seeing that only one of them worsened and actually three of them improved, while the remaining ones did not change significantly. CO2 per GDP declined, and SO2 emissions per capita, SO2 emissions per GDP, and CO2 per capita improved. We can conclude that most of the indicators for this region were not affected significantly by the global crisis.

Table 4 compares the percentage change in Ecosystem Vitality (EV) in Eastern Europe and Central Asia pre- and post-crisis. We are seeing that pre-crisis (i.e. 2007), the mean annual percentage change in EV was 0.763%. Post-crisis (i.e. 2010), this number is flat (0.001%). This is a statistically significant drop ($p=0.0080$). EV was improving by 0.763% in annual terms pre-crisis. This improvement fully disappeared post-crisis.

When we look into the seven main components of EV, we are seeing that three of them (i.e. Biodiversity and Habitat, Fisheries, and Climate Change) worsened, while one of them (i.e. Air Pollution (on ecosystem) improved. Biodiversity and Habitat was improving pre-crisis (i.e. 0.833%) in 2007, when compared to the previous year. This annual change percentage dropped to -0.004% in 2010 (i.e. the 2010 value was 0.004% lower, on average, than the previous year). This change was statistically significant ($p=0.0502$). Fisheries was flat (i.e. 0.000%) in 2007. This number dropped to -0.008% in 2010. This change was statistically significant ($p=0.0862$). Climate Change was improving at a rate of 1.574% in 2007. This number was flat (i.e. 0.000%) in 2010. This change was also statistically significant ($p=0.0044$). On the other hand, Air Pollution (on ecosystem) was flat (i.e. 0.000%) in 2007. It improved to 0.005% in 2010. This increase was statistically significant ($p=0.0278$). The other three main components of EV did not change significantly.

When we look at the 17 subcomponents, we are seeing that four of them worsened and two of them improved, while the remaining ones did not change significantly. Biome protection, Pesticide regulation, Growing stock change, and CO2 per GDP declined. On the other hand, SO2 emissions per capita and Forest cover change improved.

Table 4. The Impact of the Global Crisis on Eco. Vitality in EECA

Variables	Before			After			Wilcox.
	Mean	Median	Std.	Mean	Median	Std.	p-value
Ecosystem Vitality	0.763	0.629	1.594	0.001	0.000	0.010	0.0080
Air Pollution (on ecosys.)	0.000	0.000	0.000	0.005	0.003	0.015	0.0278
Water (on ecosystem)	0.000	0.000	0.000	0.001	-0.004	0.035	0.1787
Biodiversity and Habitat	0.833	0.000	3.298	-0.004	-0.004	0.026	0.0502
Agriculture	0.425	0.000	1.647	0.000	0.003	0.008	0.2845
Forestry	0.030	0.000	0.740	-0.001	0.000	0.003	0.1675
Fisheries	0.000	0.000	0.000	-0.008	0.005	0.029	0.0862
Climate Change	1.574	2.125	4.245	0.000	-0.003	0.014	0.0044
SO2 emissions per capita	0.000	0.000	0.000	0.005	0.005	0.014	0.0053
SO2 emissions per GDP	0.000	0.000	0.000	0.007	0.000	0.024	0.5000
Change in water quantity	0.000	0.000	0.000	0.001	-0.004	0.035	0.1787
Biome protection	1.287	0.000	5.151	-0.004	-0.006	0.026	0.0502
Marine protection	0.001	0.000	0.001	-0.001	-0.001	0.003	0.2124
Critical habitat protection	0.000	0.000	0.000	0.005	-0.003	0.015	0.3214
Agricultural subsidies	1.816	0.000	7.034	0.003	0.002	0.006	0.1030
Pesticide regulation	0.000	0.000	0.000	-0.004	-0.005	0.006	0.0857
Growing stock change	0.428	0.000	2.040	0.002	0.000	0.006	0.0397
Forest loss	0.000	0.000	0.000	0.001	0.000	0.004	0.1302

Forest cover change	-0.430	0.000	1.182	0.003	0.000	0.010	0.0051
Fishing stocks overexp.	0.000	0.000	0.000	-0.001	-0.006	0.013	0.1736
Coastal shelf fishing pres.	0.000	0.000	0.000	-0.009	-0.006	0.029	0.5000
CO2 per capita	-1.009	0.000	3.234	0.000	0.000	0.008	0.4588
CO2 per GDP	1.494	7.595	26.2	0.006	-0.001	0.028	0.0014
CO2 emis. per elec. gen.	4.331	0.302	14.2	0.020	0.006	0.063	0.2301
Renewable electricity	15.795	1.443	43.5	0.000	0.000	0.000	0.1056

Table 5 compares the percentage change in Ecosystem Vitality (EV) in Europe pre- and post-crisis. We are seeing that pre-crisis (i.e. 2007), the mean annual percentage change in EV was 1.261%. Post-crisis (i.e. 2010), this number is flat (-0.001%). This is a statistically significant drop ($p < 0.0001$). EV was improving by 1.261% in annual terms pre-crisis. This improvement fully disappeared post-crisis.

When we look into the seven main components of EV, we are seeing that two of them (i.e. Biodiversity and Habitat and Climate Change) worsened, while two of them (i.e. Air Pollution (on ecosystem and Forestry) improved. Biodiversity and Habitat was improving pre-crisis (i.e. 2.584%) in 2007, when compared to the previous year. This annual change percentage dropped to 0.001% in 2010. This change was statistically significant ($p = 0.0013$). Climate Change was improving at a rate of 3.573% in 2007. This number was flat (i.e. 0.001%) in 2010. This change was also statistically significant ($p < 0.0001$). On the other hand, Air Pollution (on ecosystem) was flat (i.e. 0.000%) in 2007. It improved to 0.001% in 2010. This increase was statistically significant ($p = 0.0153$). Also, Forestry was declining (i.e. -0.629%) in 2007. It improved to 0.001% in 2010. This increase was statistically significant ($p = 0.0433$). The other three main components of EV did not change significantly.

Table 5. The Impact of the Global Crisis on Ecosystem Vitality in Europe

Variables	Before			After			Wilcox.
	Mean	Median	Std.	Mean	Median	Std.	p-value
Ecosystem Vitality	1.261	0.51	2.44	-0.001	0.00	0.01	<0.0001
Air Pollution (on ecosys.)	0.000	0.00	0.00	0.001	0.00	0.01	0.0153
Water (on ecosystem)	0.000	0.00	0.00	-0.002	0.00	0.02	0.1233
Biodiversity and Habitat	2.584	0.00	10.41	0.001	0.00	0.00	0.0013
Agriculture	0.307	0.00	2.01	0.000	0.00	0.01	0.4770
Forestry	-0.629	0.00	3.70	0.001	0.00	0.00	0.0433
Fisheries	0.000	0.00	0.00	0.000	0.00	0.02	0.3022
Climate Change	3.573	2.30	4.04	0.001	0.00	0.01	<0.0001
SO2 emissions per capita	0.000	0.00	0.00	0.001	0.00	0.01	0.1655
SO2 emissions per GDP	0.000	0.00	0.00	0.002	0.00	0.01	0.0009
Change in water quantity	0.000	0.00	0.00	-0.002	0.00	0.02	0.1233
Biome protection	2.128	0.00	6.07	0.000	0.00	0.01	0.0005
Marine protection	0.380	0.00	0.91	0.001	0.00	0.00	0.0995
Critical habitat protection	1,388	0.00	2,404	-0.001	0.00	0.00	0.5000

Agricultural subsidies	-0.719	0.00	29.77	0.004	0.00	0.03	0.3513
Pesticide regulation	0.000	0.00	0.00	-0.002	0.00	0.00	0.1641
Growing stock change	-1.302	0.00	7.13	0.000	0.00	0.00	0.0119
Forest loss	0.000	0.00	0.00	-0.006	0.00	0.03	0.2354
Forest cover change	-0.015	0.00	3.52	0.000	0.00	0.00	0.2986
Fishing stocks overexp.	0.000	0.00	0.00	0.002	0.00	0.03	0.5000
Coastal shelf fishing pres.	0.000	0.00	0.00	-0.003	0.00	0.03	0.2123
CO2 per capita	4.118	2.15	7.60	-0.001	0.00	0.01	<0.0001
CO2 per GDP	3.362	1.96	4.18	0.002	0.00	0.01	<0.0001
CO2 emis. per elec. gen.	4.993	4.50	8.45	0.003	0.00	0.05	<0.0001
Renewable electricity	23.19	7.77	66.40	0.000	0.00	0.00	<0.0001

When we look at the 17 subcomponents, we are seeing that six of them worsened and two of them improved, while the remaining ones did not change significantly. Biome protection, Marine protection, CO2 per capita, CO2 per GDP, CO2 emissions per electricity generated, and Renewable electricity declined. On the other hand, SO2 emissions per GDP and Growing stock change improved.

Table 6 compares the percentage change in Ecosystem Vitality (EV) in Middle East and North Africa pre- and post-crisis. We are seeing that pre-crisis (i.e. 2007), the mean annual percentage change in EV was -0.703%. Post-crisis (i.e. 2010), this number is -0.002% (i.e. flat). However, this is not a statistically significant change ($p=0.2482$).

Table 6. The Impact of the Global Crisis on Ecosystem Vitality in MENA

Variables	Before			After			Wilcox.
	Mean	Median	Std.	Mean	Median	Std.	p-value
Ecosystem Vitality	-0.703	-0.114	1.609	-0.002	0.001	0.012	0.2482
Air Pollution (on ecosys.)	0.000	0.000	0.000	0.003	0.004	0.016	0.0352
Water (on ecosystem)	0.000	0.000	0.000	0.022	0.007	0.051	0.1150
Biodiversity and Habitat	0.000	0.000	0.000	0.020	0.001	0.078	0.2770
Agriculture	-3.100	0.000	12.8	0.000	0.000	0.004	0.2926
Forestry	-2.470	0.000	6.929	-0.001	0.000	0.004	0.2950
Fisheries	0.000	0.000	0.000	-0.005	-0.006	0.010	0.0012
Climate Change	-2.074	-0.130	8.007	-0.001	-0.005	0.054	0.4811
SO2 emissions per capita	0.000	0.000	0.000	0.007	0.004	0.015	0.0610
SO2 emissions per GDP	0.000	0.000	0.000	-0.001	-0.003	0.013	0.0078
Change in water quantity	0.000	0.000	0.000	0.022	0.007	0.051	0.1150
Biome protection	0.000	0.000	0.000	0.017	-0.001	0.144	0.3855
Marine protection	0.000	0.000	0.000	0.000	0.000	0.006	0.1056
Critical habitat protection	.	.	.	.	.	.	.
Agricultural subsidies	-3.100	0.000	12.8	-0.001	0.000	0.004	0.1158
Pesticide regulation	0.000	0.000	0.000	-0.001	-0.002	0.004	0.3627
Growing stock change	-6.048	0.000	15.1	0.001	0.000	0.002	0.0275

Forest loss	0.000	0.000	0.000	0.000	0.000	0.004	0.3274
Forest cover change	-0.140	0.000	0.425	-0.001	0.000	0.001	0.4179
Fishing stocks overexp.	0.000	0.000	0.000	0.002	0.002	0.009	0.1022
Coastal shelf fishing pres.	0.000	0.000	0.000	0.003	0.002	0.018	0.5000
CO2 per capita	-3.164	-0.615	7.454	0.001	0.002	0.016	0.0112
CO2 per GDP	-1.072	1.516	8.180	0.004	0.003	0.011	0.0084
CO2 emis. per elec. gen.	-2.041	-2.201	28.2	-0.223	-0.010	0.855	0.3324
Renewable electricity	-19.83	-8.806	25.3	0.000	0.000	0.000	0.0099

When we look into the seven main components of EV, we are seeing that only Fisheries indicator was affected negatively. Fisheries was flat (i.e. 0.000%) in 2007. It was -0.005% in 2010. This change is statistically significant ($p=0.0012$). On the other hand, Air Pollution (on ecosystem) improved. It was flat (i.e. 0.000%) in 2007. In 2010, it was 0.003%. This increase is statistically significant ($p=0.0352$). None of the other five main components of EV changed significantly.

When we look at the 17 subcomponents (excluding Critical habitat protection which has no data), we are seeing that only one of them worsened and actually five of them improved, while the remaining ones did not change significantly. SO2 emissions per GDP declined, while SO2 emissions per capita, Growing stock change, CO2 per capita, CO2 per GDP, and Renewable electricity improved. We can conclude that while most of the indicators for this region were not affected significantly by the global crisis, a few of them actually improved. According to these results, the MENA region was more successful than the Americas, Asia and Pacific, EECA region, and Europe in terms of EV efforts during the global crisis.

Table 7 compares the percentage change in Ecosystem Vitality (EV) in Sub-Saharan Africa pre- and post-crisis. We are seeing that pre-crisis (i.e. 2007), the mean annual percentage change in EV was -0.127%. Post-crisis (i.e. 2010), this number is flat (0.000%). However, this is not a statistically significant change ($p=0.4007$).

When we look into the seven main components of EV, we are seeing that only Agriculture was affected significantly, and in fact, it was a positive effect. Agriculture was flat (i.e. 0.000%) in 2007. It was 0.010% in 2010. This change is statistically significant ($p=0.0003$). None of the other six main components of EV changed significantly.

When we look at the 17 subcomponents, we are seeing that only two of them worsened and actually three of them improved, while the remaining ones did not change significantly. SO2 emissions per GDP and Biome protection declined, while Critical habitat protection, Pesticide regulation, and Forest cover change improved. We can conclude that this region and the MENA region were the most successful regions in terms of EV efforts during the global crisis.

Table 7. The Impact of the Global Crisis on Ecosystem Vitality in Sub-Saha. Africa

Variables	Before			After			Wilcox.
	Mean	Median	Std.	Mean	Median	Std.	p-value
Ecosystem Vitality	-0.127	-0.074	1.470	0.000	0.002	0.006	0.4007
Air Pollution (on ecosys.)	0.000	0.000	0.000	-0.003	-0.002	0.019	0.2023
Water (on ecosystem)	0.000	0.000	0.000	0.000	-0.001	0.009	0.2887
Biodiversity and Habitat	0.094	0.000	0.360	0.000	0.000	0.006	0.3837
Agriculture	0.000	0.000	0.000	0.010	0.005	0.023	0.0003
Forestry	1.079	0.000	4.168	-0.001	0.000	0.004	0.1789
Fisheries	0.000	0.000	0.000	-0.001	0.000	0.013	0.1787
Climate Change	-0.606	-0.223	4.277	0.000	0.000	0.005	0.2177
SO2 emissions per capita	0.000	0.000	0.000	-0.002	0.000	0.018	0.3940
SO2 emissions per GDP	0.000	0.000	0.000	-0.005	-0.004	0.010	0.0197
Change in water quantity	0.000	0.000	0.000	0.000	-0.001	0.009	0.2887
Biome protection	0.097	0.000	0.362	-0.001	-0.002	0.005	0.0018
Marine protection	0.000	0.000	0.000	0.001	-0.001	0.011	0.2537
Critical habitat protection	0.000	0.000	0.000	6.844	0.002	18.4	0.0576
Agricultural subsidies	0.000	0.000	0.000	0.000	0.000	0.005	0.2243
Pesticide regulation	0.000	0.000	0.000	0.031	0.006	0.047	0.0277
Growing stock change	2.553	0.000	8.745	-0.003	0.000	0.008	0.2201
Forest loss	0.000	0.000	0.000	-0.001	0.000	0.007	0.5000
Forest cover change	-1.396	-0.134	3.757	-0.010	0.000	0.060	0.0147
Fishing stocks overexp.	0.000	0.000	0.000	-0.001	0.000	0.019	0.5000
Coastal shelf fishing pres.	0.000	0.000	0.000	0.000	-0.001	0.016	0.2662
CO2 per capita	-0.494	0.000	2.248	0.001	0.000	0.003	0.1306
CO2 per GDP	-0.879	-0.233	4.214	0.000	0.000	0.005	0.4007
CO2 emis. per elec. gen.	4.846	-0.259	33.7	-0.006	-0.002	0.034	0.3419
Renewable electricity	5.794	0.017	17.8	0.000	0.000	0.000	0.1850

5. CONCLUSION

This study examines the impact of the 2008-2009 global economic crisis on ecosystem vitality indicators in six regions of the world. The regions that are examined are the Americas, Asia and Pacific, Eastern Europe and Central Asia, Europe, Middle East and North Africa, and Sub-Saharan Africa. We use a dataset that covers 132 countries in total. This dataset was created by Yale University and Columbia University in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission.

We use nonparametric tests to compare the pre-crisis period to the post-crisis period. For the pre-crisis period, we take the 2007 values, and for the post-crisis period, we take the 2010 values. Our results show that the main "Ecosystem Vitality" indicator significantly deteriorated in three regions. These are the Americas, Eastern Europe and Central Asia, and Europe. This main indicator value did not significantly deteriorate in Asia and Pacific, Middle East and North Africa, and Sub-Saharan Africa

(this indicator actually improved in Middle East and North Africa and Sub-Saharan Africa, but the change was not statistically significant).

In the Americas, three of the components worsened, one improved, and the remaining three indicators did not change. The Water (on ecosystem), the Climate Change and the Fisheries indicators worsened but the Forestry indicator improved. The other three indicators did not change.

In Eastern Europe and Central Asia, three of the components worsened, one improved, and the remaining three indicators did not change. The impact on Biodiversity and Habitat, Fisheries and Climate Change were significantly negative, but Air Pollution (on ecosystem) improved. The other three indicators did not change.

In Europe, two of the components worsened, two of them improved, and the remaining three did not change. The impact on Biodiversity and Habitat and Climate Change were significantly negative, but Air Pollution (on ecosystem) and Forestry improved. The other three indicators did not change.

In the other three regions, very few components were affected. In Asia and Pacific, only Fisheries declined. None of the other components changed significantly. In Middle East and Africa, Fisheries declined and Air Pollution (on ecosystem) improved. None of the other main components changed significantly. In Sub-Saharan Africa, agriculture improved. None of the other main components changed significantly. Therefore, we can conclude that for these three regions, the impact was limited and even that limited impact was mixed (i.e. Sub-Saharan Africa only had a positive impact which was on one component).

This study shows which ecosystem vitality categories are affected more negatively in each region when a global crisis hits. We suggest policymakers to take precautions in these areas when facing the possibility of an economic crisis.

Our findings show that different regions of the world were affected in different ways during the global crisis. Countries in the Americas, Eastern Europe and Central Asia, and Europe suffered more in terms of ecosystem vitality. While these regions could not handle the economic crisis well, it is clear that the countries in Asia and Pacific, Middle East and North Africa, and Sub-Saharan Africa were more successful in continuing their sustainability efforts.

This current study shows that, in certain regions (i.e. the Americas, Europe, and Eastern Europe and Central Asia), ecosystem vitality efforts are more dependent on the economy. When faced with an economic crisis, it seems like companies and citizens in these countries, pressured by the worsening economy, tend to violate laws and regulations more while governments are losing control. Therefore, the state of the economy (and/or incomes) is more closely related to different aspects of ecosystem in these countries. "Climate change" is the most affected area. In all three regions, the "Climate change" measure worsened during the crisis. "Fisheries" and "Biodiversity and habitat" are in the second most affected group. Governments and policymakers in these regions should be more careful about potential deteriorations in these areas. In order to protect these certain aspects of the ecosystem, they should have an action plan in place, so that as soon as economic troubles start to appear, the established measures/actions can be immediately initialized.

6. REFERENCES

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