

Environmental Sustainability in East Asia:  
Policies and Technological Output

Matthew A. Shapiro<sup>1</sup>  
Illinois Institute of Technology  
[matthew.shapiro@iit.edu](mailto:matthew.shapiro@iit.edu)

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**Abstract**

This paper examines environmental policies in East Asia – Japan, Taiwan, Korea, and China – and the correlated R&D output. The analysis is multifaceted and considers international, regional, and domestic approaches. The pattern of policies and research output to address the environment is strong in all four of these countries, and China has been particularly prolific in the number of climate change-oriented publications. There is a disconnect, however, between China's environmental targets and those of the other three countries. The opportunity for China's immediate neighbors to have a positive impact on its environment (and ultimately theirs) lies in regional research projects such as the APPCDC and technology transfer programs like the CDM. Quantitative analysis for the 2000-2008 period is based on data from the USPTO, ISI Web of Science, and ministerial-level publications.

**Keywords:** greenhouse gas, greenhouse effect, East Asia, regionalism, climate change, environmental policies, S&T policies, R&D, technology transfer

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<sup>1</sup> Contact information: [matthew.shapiro@iit.edu](mailto:matthew.shapiro@iit.edu), Department of Social Sciences, 3301 S. Dearborn St., SH 116, Chicago, IL, 60616. I am grateful for the assistance of Bernat Oliveres Kunzi in compiling the list of Japanese, Taiwanese, Korean, and Chinese environmental policies and for Tom Tsai's analysis of air pollution policies.

## I. INTRODUCTION

In the three decades following World War II, countries in the East Asian region implemented a selection of industrial and international economic policies to achieve sustainable economic growth and development. In the immediately following period, from the mid-1980s to the early twenty-first century, policies shifted toward science and technology (S&T) output and the fostering of research capabilities. This pattern is largely consistent with the pattern of technological catch-up described by Nelson and Phelps (1966), as universities, government research institutes (GRIs), and firms increased the competitiveness of their respective national innovation systems.<sup>2</sup> In the last eight to nine years, these efforts have not diminished but have been supplemented with specific targets to address greenhouse gas (GHG) emissions and other climate change-related phenomena. This paper establishes the positive connection between policies related to environmental sustainability and the related research output. This relationship is intuitive in most cases, so a comparative analysis of international, regional, and domestic environmental policies is applied to determine precisely how GHG-related R&D is correlated with existing directives and regulations.

Based on the assumption that science and technology policies are conjoined with explicit environmental and energy policies, the analysis of this paper includes an examination of international agreements as they relate to the East Asian countries. There is a worldwide effort to address GHG emissions, shown recently with the promotion of a “Global Green New Deal” by the United Nations (UN) in late 2008,<sup>3</sup> and the East Asian countries are participating largely on par with other developed countries. In the Northeast Asian region, there have also been attempts to coordinate across borders, which is a notable extension of the dynamics of East Asian regionalism described by Pempel (2006).<sup>4</sup> Yet, all efforts from above are ultimately dependent on domestic policies and institutions, and we appropriately scrutinize these countries’ domestic environmental policies over the post-war era.

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<sup>2</sup> National innovations systems are treated comparatively in Nelson (1993).

<sup>3</sup> The Global Green New Deal simultaneously addresses problems related to the environment and to rising levels of unemployment.

<sup>4</sup> Pempel (2006) emphasizes horizontal production networks, foreign direct investment, and export processing zones.

The analytical method used in this paper is distinct from other analyses which are rooted at the macro-level. Applying a standard production function framework to the relationship between GHG-related patents and sources of R&D funding at the country level, Shapiro (2009) determines there are degrees of both market failure and government failure in R&D. At the macro-level, though, case-specific information is rarely entertained, so there is a distinct advantage of using a micro-level analytical approach, given that R&D is affected by policies on a number of levels.<sup>5</sup>

The results and conclusions offered here are helpful in understanding the roots and the future prospects of Japan, Taiwan, Korea, and China. On another level, this paper allows us to revisit the transferability and replicability of the East Asian case. This line of inquiry was initially established through economic growth-based analyses by the World Bank (1993), Evans (1998), and others, but the context here much different. With an anthropogenic climate change orientation, policymaking reflects an innovative combination of short-term, medium-term, and long-term goals.<sup>6</sup> In these contexts, change is made at the margins, where reductions of GHG emissions are cheapest and easiest (Fischer and Newell, 2008), where S&T policies and output have the potential to reduce these costs (Jaffe, et al., 2004; and Stavins, 2003), and where Japan, Taiwan, Korea, and China are uniquely suited to affect each other.

To address the issues outlined above, this paper is divided up into four additional sections. Section two examines GHG-related S&T output in East Asia. In section three, international and (East Asian) regional coordination of environmental policymaking agendas are described in detail. Section four examines the specific domestic environmental policies of these four countries. Final conclusions are offered in the fifth section, with particular attention to the issue of transferability and replicability, both within the region and beyond.

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<sup>5</sup> If the government provides extensive support to private sector research efforts, concerns about knowledge spillovers lead the firm to invest less than the socially optimal level of R&D. Such market failure may be remedied in a number of ways by the government, particularly through public-private R&D consortia (Stiglitz and Wallsten, 1999). However, if the government is funding the most commercially promising proposals they receive, they are effectively supporting projects that firms would likely have financed on their own (Wallsten, 2000), resulting in government failure. On this count, David, et al. (2000) find no conclusive evidence that government-funded R&D crowds out private-funded R&D.

<sup>6</sup> Rosenbaum (2007) adeptly emphasizes the distinctions between these different temporal orientations.

## II. S&T OUTPUT IN EAST ASIA

A fundamental challenge to grouping together these four countries are differences in developmental paths. Japan, followed by Korea and Taiwan (and Singapore and Hong Kong), are ubiquitously treated as evidence of an East Asian growth “miracle”,<sup>7</sup> having accomplished an effective transition from import substitution and industrialization policies to export orientation from the 1960s to the 1970s.<sup>8</sup> China, on the other hand, experienced virtual stagnation until reforms were initiated in 1978, and growth was incremental until the mid-1990s. Since then, however, China has thrust itself into the international economic spotlight, having become both the world’s largest exporter and a prime financier of other countries’ debt.

While large amounts of exports and capital account surpluses are poor indicators and not necessarily prerequisites of effective environmental policymaking, they are correlated with overall economic growth and, in turn, a more robust national innovation system. Environmental degradation-preventative measures are technology-intensive, and R&D output is a viable assessment tool. To preface a more direct look at environmental policies in Japan, Taiwan, Korea, and China, environmental research output measured by patents and publications is presented in this section. Based on development paths, one would expect Japan’s output to be greatest, followed by Taiwan and Korea, and then China.

Patent data is becoming increasingly reliable and accessible as a measure of innovation output, verified by attempts to bolster the integrity of patent statistics, such as OECD (2008). There are many aspects of GHG patent output which must be detailed, especially as this specific patenting area has been given virtually no attention in the existing literature. Publications, as well, has been given scant attention in the literature in terms of their GHG focus. Data collection for patents and publications has been done through the online patent and publications search functions of the USPTO and the Web of Science, respectively. The parameters of this search are based on two criteria: inclusion of either “greenhouse effect” or “greenhouse gas” in the patent description or the article’s

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<sup>7</sup> See World Bank (1993) for complete details.

<sup>8</sup> This is true, despite the financial crisis which plagued the region in 1997-98.

topic.<sup>9</sup> These keywords are by no means all-inclusive parameters to capture the degree of GHG-oriented innovation, but a cursory analysis of a number of keywords over the relevant time period confirms that these two terms are greatest in number and cover the widest area of industry classes.<sup>10,11</sup>

Globally, GHG-related output – both patents and publications – is dominated by the US. Presented in Table 1 for the 2000-2008 period, Japan is the second-most innovative country and trails the US by a factor of approximately three. At the same time, Japan has been producing more than three to four times more patents than Taiwan, Korea, and China combined, over the 2000-2008 time period. Nevertheless, China is producing GHG-related patents on par with a number of European countries, while Korea and Taiwan take up the seventh and eighth positions among the world’s most GHG patenting countries. These are relatively unremarkable positions, given that Germany, in fifth

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<sup>9</sup> For patents, the issue date is distinct from the filing (or priority) date in that the former typically occurs from one to four years after the latter. More importantly, the filing date is not available until the patent has been issued, and it simply is not an available search parameter. Thus, when collecting patent data, it is particularly important to account for the filing date to sufficiently represent the effects of the time lag between the application and issue dates. Also drawn from the USPTO search function are the issue date-ordered patent numbers, the assignee’s country of origin, and the inventor’s country of origin. More specific details on the inventor(s) is also collected, such as whether the inventor is at a university, a government research institute (GRI), or at a firm, and whether the inventor’s institution is also the assignee’s institution. If the assignee has no affiliation, this is also noted. Given the international scope of this analysis, non-English-based institutions were frequently left in their language of origin, calling for translation and further research. Fortunately, there are a number of computing-based tools available to facilitate this process, but the search itself was time consuming, especially when determining whether a GRI is in fact under the direct guidance and funding of the government or whether it functions as a corporation. The United States patent codes (USPC) have also been collected from the USPTO, both major and minor.

<sup>10</sup> The top nine most patented industries in GHG-related output are: chemistry of inorganic compounds; power plants; refrigeration; wells; chemistry – electrical current producing apparatus, product, and process; compositions; chemistry – molecular biology and microbiology; liquid purification or separation; and gas separation – processes.

<sup>11</sup> Within these two key terms there also exists the issue of relevancy, as there may be correlation between “greenhouse effect” and “greenhouse gas” and non-sustainability-oriented innovations. The original, uncleaned dataset includes 1,050 patents for the period from 2000 to 2008. Within this data however, USPC 47 – plant husbandry – appeared seventeen times, only one of which was relevant to a discussion of GHGs. The remainder was specific to the greenhouse effect as it was used in the original context: the phenomenon of keeping plants warm through glass paneled or plastic housing. Thus, of these seventeen patents, only one has been included in the final version of the dataset used in this analysis. Similarly, the four patents listed under USPC 52 (static structures, e.g., buildings), one under USPC 135 (tent, canopy, umbrella, or cane), two under USPC 219 (electric heating), one under USPC 237 (heating systems), eleven under USPC 296 (land vehicles, bodies and tops), one under USPC 351 (optics, eye examining, vision testing and correcting), five from USPC 362 (illumination), one under USPC 385 (optical waveguides), and ten from USPC 428 (stock material or miscellaneous articles) use one of the key terms in a context other than sustainability-oriented R&D. Patents which specify carbon neutrality, carbon sequestration,

position, and Canada, in third position, have twice and (over) thrice as many patents, respectively. Within the region, presented in Fig. 1, Taiwan has shown the most dramatic increase in GHG-related patents, particularly from 2004. GHG-related publications are a very different story, with China producing nearly as many as Japan over the 2000-2008 period and taking on exponential proportions (see Fig. 2).

[Table 1 here]

[Fig. 1 here]

[Fig. 2 here]

A closer examination GHG-related patents and publications reveals three additional observations. First, there were largely no instances of international coordination in patenting.<sup>12</sup> The exception is Japanese patents, which included six that were assigned to entities based in the US, and one each to German and Australian research entities. R&D collaboration within each country was also not very great. In Japan, there were four patents with assignees from both GRIs and private firms; in Korea, one patent was produced between a GRI and a firm, and another patent was based on university-GRI collaboration. Taiwan had no GHG-based patents resulting from R&D collaboration, and there were no instances of R&D collaboration in China. Second, there is a relative dominance of private firm patenting output in Japan and Korea, while GHG-related patent holders in Taiwan and China are represented by a lack of institutional affiliation.<sup>13</sup>

Third, there is a clear difference in emphases between selected keywords. Shown in Fig. 4, patents are clearly targeting the greenhouse effect, while publications focus on greenhouse gases. Whether this is an indicator of patent producers' attempts to more effectively market their research output is not clear, but it does identify the distinction between process and development R&D arising through patents and the emphasis of basic research specifically on greenhouse gas mitigation.<sup>14</sup> With so many publications

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photovoltaics, wind turbines, or renewables are indeed components of sustainability-oriented innovation, but parsing out the most relevant patents requires much more care.

<sup>12</sup> Lee (2009) acknowledges that S&T globalization is vastly lower than the average rate for the OECD countries, with regard to Korea.

<sup>13</sup> No data has yet been compiled to create a similar assessment for GHG-related publications.

<sup>14</sup> This is based on the assumption that publications are representative of basic research while patents are more process oriented, in line with the typology offered in OECD (2002).

coming out of China, it can be stated that the “greenhouse effect” is largely untreated in China.

[Fig. 3 here]

[Fig. 4 here]

The trends described in this section indicate that Korea, Taiwan, and China are well on their way to becoming major producers of GHG-related technologies, albeit nothing yet on the scale of Japan in terms of patents. The peaks and valleys presented in Figs. 1 and 2 are not strong confirmation that the future will hold sharp upward trends, except for the Chinese case. Indeed, all of these countries are performing relatively well, but China has become the most research productive country of the region, with the potential to tap into its reserve of research capital and labor for even greater advancements.

### **III. INTERNATIONAL & REGIONAL COORDINATION**

Environmental protection is an inherent right and has been well integrated into the regulatory structures of Japan, Taiwan, Korea, and China. Environmental regulations and especially those treating GHG emissions have generated strong responses from supranational entities such as the UN, the World Bank, and international non-governmental organizations. For domestic policymakers, the long-term, cross-national, and uncertain (in terms of degree) impacts of GHGs make it a relatively unattractive cornerstone for any environmental agenda, given the hazards and conflicts of policymaking in general, described by Stone (2001), and the two-level coordination problems modeled by Putnam (1988). In this section, we will examine the exact international institutions as well as regional efforts within East Asia. The immediately following section connects these two levels with the domestic policies of Japan, Taiwan, Korea, and China to determine whether domestic policies are consistent with the international and regional norms.

International environmental coordination began with the 1965 UN Development Program, which has helped distribute funds and support in the interests of biological diversity and global warming. The UN Environmental Program was created in 1972 by the Stockholm Conference to oversee cross-national environmental concerns and monitor

the environment on a global scale. The Convention on Long Range Transboundary Air Pollution was initiated in 1979, and the Montreal Protocol to address pollution affecting the ozone layer was first ratified in 1987. In 1992, the UN Commission on Sustainable Development was created to monitor the programs which began through the 1992 Rio conference (United Nations, 1993).<sup>15</sup> Sustainable development was revisited and updated once again in 2002, on the tenth anniversary of the Earth Summit at the World Summit on Sustainable Development in Johannesburg. In the interim, the UN Millennium Development Goals (MDG) arose from the Millennium Summit in 2000 to determine the function of the UN in the 21<sup>st</sup> century. These eight goals are effectively the largest attempt to address GHG emissions in tandem with other sustainability-related measures. From 2006, the Kyoto Protocol to the United Nations Framework Convention on Climate Change was officially implemented, but the MDGs are distinct from the Kyoto Protocol, which focuses on reductions in greenhouse gases by industrialized countries.

More recently, support for international coordination was offered by Hillary Clinton (2009), who attempted to rally the world behind the revamped American effort to approach climate change at the international level. She proposed an action plan oriented around science and technological efforts but also maintained that the knowledge will not flow freely to the developing world.<sup>16</sup>

Japan, Taiwan, Korea, and China are participants in the UN (although Taiwan was formally replaced by mainland China in 1971).<sup>17</sup> They are all involved with what is perhaps the greatest contribution of UN-based programs to anthropogenic climate change: the Clean Development Mechanism (CDM). Schneider, et al (2008) attest that the CDM affords developing countries the opportunity to receive key technologies, although institutional barriers may limit such transfers. China has been the most prevalent

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<sup>15</sup> In this case, sustainable development can be defined in terms of generational impacts, where the needs of the present are met without compromising the future's ability to meet their own needs (World Commission on Environment and Development, 1987).

<sup>16</sup> It is encouraging that the energy and environmental landscape has changed so rapidly in Washington, given the large and growing consensus of the anthropogenic sources of GHGs. Policymakers, interest groups, business leaders, and a more informed public are turning increasingly to the research community for solutions. This is consistent with historical examinations of technological advances and their related social and economic outcomes. If Rosenberg's (1982) observations of innovation affecting the long-run economic viability of key resources such as steel, aluminium, and coal are any predictor of how S&T may affect GHG emissions, tracking research output is an absolute necessity.



recipient of CDM projects, amounting to 1,682 of a global total of 4,660, or 36 percent of all CDM projects (UNEP Risoe, 2009).<sup>18</sup> Among these 1,682 projects, 239 (14.2 percent) are initiated out of Japan. Yet, the CDM is limited by the market-based constraints of the spot market to sell climate credits as well as the market to produce energy at a cost-effective level. Schneider, et al. (2008) acknowledge these potential barriers, but the evidence of technology transfers is not well established, at least for now. Schneider, et al. (2008) also fail distinguish between non-CDM participants such as Taiwan. If SMEs – the dominant industrial structure in Taiwan – are indeed more likely to share vital information with developing countries, a hypothesis accepted by Marcotte and Niosi (2005), the CDM neglects one of China’s most important neighbors.

Region-based efforts are not without their own set of challenges. Nam (2002) has found that the Northeast Asia region is plagued by political and institutional constraints to regional environmental policy coordination, despite the ecological interdependence and the shared air pollution, yellow dust, and marine pollution.<sup>19</sup> Certainly there have been a number of bilateral and multilateral efforts within the region, such as the Environment Congress for Asia and the Pacific, the Northeast Asian Conference of Environmental Cooperation, the Northeast Asian Subregional Program of Environmental Cooperation, the Northwest Pacific Action Program, the Tripartite Environment Ministers Meeting, and discussions at regional economic fora (APEC, ASEAN plus Three). Yet, studies such as Nam (2002) and Lee (2002) omit from their analysis the two driving forces of this paper: S&T efforts and supra-regional (i.e., international) targets of GHGs.

The greatest potential for the East Asian countries to establish GHG-related connections within and beyond the region lies in the Asia Pacific Partnership on Clean Development and Climate (APPCDC). This voluntary partnership involves Australia, Canada, China, Japan, Korea, and the US, with a goal of developing key technologies. Classified as a technology-oriented agreement (TOA), this has been found to be more successful than the broader UN-based agreements listed above (De Coninck, et al., 2008),

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<sup>17</sup> Japan became a formal member of the UN in 1956, Taiwan in 1945, Korea in 1991, and China in 1971 (when it formally replaced Taiwan as the “true” Chinese member).

<sup>18</sup> India represents another 26 percent of the total number of CDM projects.

<sup>19</sup> See Lee (2002) for more details on these three interdependencies.

excluding the CDM. A list and map of current projects within Northeast Asia are presented in Table 2 and Fig. 5, respectively. APPCDC is an ideal case study for future analyses of the mitigation of GHGs in the context of R&D and S&T in Northeast Asia, integrating a spectrum of industries with direct connections to anthropogenic climate change. As is the case with the CDM, performance and outcome measures are not yet available for the APPCDC.

[Table 2 here]

[Fig. 5 here]

## V. DOMESTIC ENVIRONMENTAL EFFORTS

Domestic efforts to reduce GHGs are based on both S&T policy structures and environmental policy structures, which is consistent with the R&D-GHG connection established in the first two sections of this paper. This section presents the relevant S&T policies for Japan, Taiwan, Korea, and China, followed by a case study of air pollution policies. An important observation is made: China, despite its prolific output of publications, is particularly vague about GHGs in its policies.

Japan's S&T efforts now reflect the third instalment of the Science and Technology Basic Law enacted in 1995.<sup>20</sup> The Third Basic Plan (2006-2010) is subdivided into six goals, including sustainable development defined as economic growth combined with environmental protection. The major R&D themes, thus, include climate change, hydrological cycles and solute transport in watersheds, ecosystem management, 3R (reduce, reuse, recycle) technologies, and biomass utilization technologies. In addition, the largest share of S&T budget allocations for 2009 are for low-carbon technologies, at 164 billion yen (Wada, 2009).<sup>21</sup> The emphasis on low-carbon technologies is also indicative of Japan's long term approach to S&T, further exemplified with the 2025 end goal of the "Innovation 25" guidelines and the "Cool Earth 50" proposal (G8 summit in 2007) to halve global GHGs by 2050.

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<sup>20</sup> The First Basic Plan (1996-2000) targeted increases in government expenditures and a new R&D system; the Second Basic Plan (2001-2005) focused on increases in the knowledge base and increasing the competition for research funds.

<sup>21</sup> Innovative technologies receive 52.3 billion yen, S&T diplomacy receive 46.7 billion yen, regional (domestic) system promotion receives 69.3 billion yen, and public-private R&D projects received 19.5 billion yen.

Taiwan's Agenda 21 approaches sustainable development in a general sense, with the National Environmental Protection Plan and the Sustainable Development Action Plan offering details (Republic of China Executive Yuan, 2004). The Basic Environment Act of 2002, Article 23, makes a call for the fostering of green industries and non-nuclear renewable energy sources. At the institutional level, the Ministry of Economic Affairs (Bureau of Energy) is focused on sustainability and efficiency as the core goals of Taiwan's energy policy. Greater amounts of R&D subsidies from the government are a policy prescription in pursuit of these goals (Chen, 2008), represented with the establishment of the Taiwan Industrial Greenhouse Office (TIGO) under the Ministry of Economic Affairs, in 2006. TIGO was established specifically to reach a GHG-reduction goal of ten percent (based on 2000 emissions) by 2015, and it is also responsible for coordinating the various agencies within the Ministry of Economic Affairs in pursuit of GHG reductions and the technology to satisfy these efforts.

In Korea, policymakers similarly conflate S&T efforts and GHG-reducing R&D. Kim (2009) identifies a government-driven, technological push of green technology, to minimize consumption, utilize recyclables and renewables, and reduce the environmental load. The socio-economic pull of a new, low-carbon paradigm is achieved through policies. Taken together, the three elements of green growth<sup>22</sup> are achievable, particularly as 3.7 billion dollars of 23 billion dollars in government funding over the next five years will be invested in renewable technologies such as photovoltaics and wind turbines (Kim, 2009). Korea is also very involved in creating market-based incentives through the tax system, reliable signalling, a cap-and-trade system, the establishment of the Green Growth Committee,<sup>23</sup> and the Green New Deal Policy.<sup>24</sup>

China has had a strategy for sustainable development in place since 1996 (Rongping, 2009), but its pattern is exceptional. While energy efficiency and environmental preservation are outlined in very clear terms, a notable absence from this strategy is the effort to mitigate or even address GHGs. This pattern is also identified in the case study of air pollution policies for the region, to which we now turn.

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<sup>22</sup> The three elements: minimize energy consumption while pursuing economic growth, minimize GHG emissions, and develop new growth engines (Kim, 2009).

<sup>23</sup> The Green Growth Committee is comprised of a total of fifty individuals from the public and private sectors to coordinate policies and implementation strategies.

As a preface, from the 1940s to the present, there have been a total of 326 policies enacted by Japan, Taiwan, Korea, and China.<sup>25</sup> Efforts have been taken in recent years to address certain environmental issues in these four countries, but the bulk of such policies have originated in China and Taiwan, as shown in Fig. 6. Korea, as well, has been somewhat prolific in the 1990s and 2000s, but pale in comparison to Taiwan and China. In an attempt to explore the pattern of policymaking in each of these countries over time, Table 3(a-b) presents a keyword analysis of these 326 policies. Pollution was treated in the 1960s in Japan, Taiwan, and Korea, and revisited in Taiwan in the 1990s and 2000s. China began addressing pollution in its environmental policymaking agenda from the 1980s to the present. Waste-related environmental policies have largely been an on-going issue for these four countries, which can be expected given the increases in population and consumption which accompany economic growth.

Among these domestic policies, air pollution regulations most aptly address GHGs, specifically carbon dioxide (CO<sub>2</sub>), methane, nitrous oxides (NO<sub>x</sub>), and chlorofluorocarbons (CFCs).<sup>26</sup> This is represented, or should be represented, by Japan's Law Concerning the Promotion of the Measures to Cope with Global Warming and, the Bill on Amendments of the Climate Change Policy Law,<sup>27</sup> the Clean Air Conservation Act of Korea (last revised April 27, 2007), the Basic Environment Act of 2002 and the Air Pollution Control Act (APA) (last revised in 2006) of Taiwan, and the National Eleventh Five-Year Plan for Environmental Protection (2006-2010) and the Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution in China.

Article 2 of Japan's Law Concerning the Promotion of the Measures to Cope with Global Warming defines GHGs in line with those mentioned above and also includes sulfur hexafluoride. The Law also treats climate change education for the public, calls for leadership by the government, and highlights the ways businesses and local governments can limit GHGs. The Bill on Amendments of the Climate Change Policy Law, on the other hand, formalizes Japan's GHG reduction commitment of six percent below the

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<sup>24</sup> The Green New Deal Policy is designed to create jobs in industries oriented toward sustainability.

<sup>25</sup> The full list of policies in these four countries from the 1940s to the present is included in the Appendix.

<sup>26</sup> Tom Tsai must be acknowledged for his help in this analysis of air pollution policies.

Kyoto Protocol regulations and states that the central government will formulate the Kyoto Target Achievement Plan to reduce GHG emissions, which includes an emissions cap system, the Clean Development Mechanism, and research subsidies.<sup>28</sup>

In Taiwan, Chapter 3, Article 21 of the Basic Environment Act states that, “Government entities at all levels shall actively adopt measures to control carbon dioxide emissions and establish related plans to mitigate the greenhouse effect.” Despite this explicit reference to carbon dioxide in the Basic Environment, the list of pollutants included in the Enforcement Rules of the more recent APA includes all anthropogenic GHGs besides carbon dioxide. Yet, the APA Control Fee Collection Regulations establish emissions performance standards for selected industries, including electric power generation and petrochemical production.<sup>29</sup> Stationary producers of the pollutants included in this law are also subject to an emissions fee.<sup>30</sup> This policy does not include any subsidies for renewables or R&D, and does not mandate the use of renewable energy sources.

Relative to the other three countries, the Clean Air Conservation Act of Korea treats the aforementioned GHGs with the most detail, covering a variety of topics related to air pollution, including the regulation of marine and motor vehicle emissions, incentives for low emission vehicles, air quality assessment standards, program funding, interaction with other laws, emissions costs, and violation penalties. Article 2.2 of the Act includes the following among the list of GHGs: CO<sub>2</sub>, methane, NO<sub>x</sub>'s, hydrofluorocarbon, perfluorocarbon, and sulfur hexafluoride, the latter effectively expanding the list of GHGs. Articles 11 and 16(5) allow for the government to set an emissions performance standard, with the former assigning the responsibility of developing a comprehensive plan for the improvement of the atmospheric environment to the Minister of Environment. This includes the monitoring of existing GHG levels, the setting of GHG reduction goals and methods to achieve such goals, and jurisdiction over international cooperation regarding climate change. Article 16(5) empowers the Minister

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<sup>27</sup> These two regulations from Japan were preferred to the Air Pollution Control Law of 1996, which primarily treats SO<sub>2</sub>, soot, and other air pollutants.

<sup>28</sup> R&D subsidies in Japan are under the jurisdiction of a separate ministry: the Research and Development Division of the Industrial Science and Technology Policy and Environment Bureau of the Ministry of Economy, Trade and Industry (METI).

<sup>29</sup> This information can be found at <http://law.epa.gov.tw/en/laws/495268338.html>.

of Environment to set emissions standards stricter than those established by Ordinance of the Ministry of Environment in areas that have been designated by the Minister of Environment as “special measures areas,” which include areas in which environmental damage is deemed remarkable or likely to become remarkable. Article 35 essentially allows the government to impose an emissions price on businesses that emit GHGs and Article 58 allows for the government to subsidize the adoption of renewable fuel technology for vehicles.<sup>31</sup>

China’s National Eleventh Five-Year Plan for Environmental Protection (2006-2010) makes nearly no references to GHGs or climate change. Rather, extensive details are offered to reduce the amount of sulfur dioxide (SO<sub>2</sub>) emitted from coal burning power plants. No mention is made of the substantial amount of carbon dioxide that accompanies sulfur dioxide as a pollutant from coal fired power plants. In a similar light, the Law of the People’s Republic of China on the Prevention and Control of Atmospheric Pollution is exceptionally vague regarding GHGs, making no mention of GHGs or other emitted gases beyond SO<sub>2</sub>. Article 9 does reference the importance of S&T efforts and renewable energy as controls for air pollution, but a connection between such efforts and GHGs is not established.<sup>32</sup>

There are a number of other complications arising from a close reading of Chinese environmental regulations. First, there are no requirements to periodically assess air quality and to make such assessments public. There is also excessive decentralization of enforcement regulations in the Chinese case, which is bound to result in major coordination problems, especially given Beijing’s record of government failure resulting from over-decentralization.<sup>33</sup> In Article 3 of the Chinese law, for example, it lays the

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<sup>30</sup> This information can be found at <http://law.epa.gov.tw/en/laws/660572544>.

<sup>31</sup> More specifically, Article 58(1) allows the heads of local governments to order that the owners of light vehicles convert their vehicles to low-pollution vehicles. Article 58(2) allows the state or local governments to provide loans or subsidies to those who purchase low emissions vehicles, convert existing vehicles to low emissions standards, setup zero emissions fuel stations.

<sup>32</sup> Article 10 of the Law of the People’s Republic of China on the Prevention and Control of Atmospheric Pollution makes a vague allusion to improving the atmosphere, but it also lacks specifics: “The people’s governments at various levels shall redouble their efforts in afforestation, grass-planting, urban and rural greening, and take effective measures to do well the work of prevention and control of sand so as to improve the atmospheric environment.”

<sup>33</sup> In China, for example, one of the most severe problems plaguing the CCP is the lack of oversight of local CCP officials. Beijing regularly imprisons or executes corrupt officials, but this is a symptom of the problem rather than a solution.

responsibility on the local governments to ensure that the law is upheld within their jurisdictions.

It is clear that China's air regulations are geared primarily toward the reduction of sulfur dioxide emissions, which is the cause of acid precipitation or acid rain. The unfortunate lack of emphasis on GHGs and their long term effects has been superseded with short and medium range goals to reduce acid rain. This is, however, not necessarily surprising. There is no viable standard to measure the effect of acid rain on industry, utilities, and automobiles (Rosenbaum, 2007), so a broad-based regulation may be among the most effective. In China, especially, the accelerated corrosion produced by acid rain is a clear threat to the country's continued industrialization drive, representing a significant cost if railroad rails, metal bridges, shipping containers, etc. require replacement twice or thrice as fast as normal.

## **V. CONCLUSION**

This paper has examined GHG mitigation efforts through three different forces – international, regional, and domestic – and two different mechanisms – S&T policy and environmental policy. There is an increasingly robust relationship between international accords and domestic policymaking with regard to the environment. This can be most recently observed in the US with the Obama administration's leadership in having carbon dioxide classified as a pollutant, for which many countries in the international community had been advocating for a number of years. The context of this discussion, though, has been Northeast Asia, which is significant for its S&T capabilities, its ability to create medium-term policies with strong state leadership, and the increasing emissions of GHGs from China.

The long-term, cross-national negative impacts of GHGs makes it a relatively unattractive cornerstone for any domestic environmental agenda, given the hazards and conflicts of policymaking, but the domestic policies of Japan, Taiwan, Korea, and China are largely consistent with the international norms. Yet, China's S&T output in the form of publications is GHG-centered, not greenhouse effect-centered. There is rhetoric involved with S&T targeting of the greenhouse effect, particularly the associated admission that the sources of GHGs are anthropogenic. These findings are confirmed

with examination of the specific environmental policies in China through keyword and case study analysis.

Regionalism is the crucial component here. The economic force of the Northeast Asian region is a function of its continued ability to innovate, grow, and innovate more.<sup>34</sup> Without updates to existing manufacturing and energy production methods, the medium/long-term costs are certain to be great, given the pattern of GHG emissions, particularly for China. On one level, attempts to reign in acid precipitation output are evidence of successful regional coordination. On another level, however, China is moderately stagnant in addressing the long term effects of GHGs. The region can help shore up some of these deficiencies by advancing technology transfer through the CDM and the APPCDC, the latter of which is expected to have the benefits of technology transfer within a more efficient TOA framework. In the context of the CDM, Japan has clearly taken the lead among the East Asia countries.

Greater S&T coordination between countries is essential. International research consortia are ideal, but region-based research efforts to address GHGs are an immediately viable alternative. Even in a non-GHG-related context, international R&D collaboration for all patents represents less than ten percent of all patent output (USPTO, 2009). There is even less occurrence in the case of GHG-related R&D. China's S&T capabilities are sufficient and are certain to continue to grow with the proper modeling and S&T relations with Japan, Korea, and Taiwan. The US is having difficulties managing its own affairs within North America and refuses to freely provide knowledge and technological output (Clinton, 2009). China – and the rest of the world, for that matter – cannot count on a bilateral debt-for-technology arrangement with the US.

For other regions of the world which are having difficulties establishing a regional standard which conforms with the UN or other international treaties and/or TOAs, the East Asian model may perhaps one day be the standard. When East Asian domestic and regional S&T efforts are coordinated to deal with anthropogenic climate change, the

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<sup>34</sup> Northeast Asia is not alone in these challenges: the case for regionalism in the context of high levels of GHG emissions was presented at the most recent Summit of the Americas meeting of the Summit Implementation Review Group.<sup>34</sup> Energy efficiency in the Americas – with its clear connection to environmental sustainability – was a main theme of the meeting. The reality is that there do not yet exist a significant number of region-based plans or treaties to address GHG emissions. Even the well-established,



“East Asian GHG reduction model” will attract even more attention than the previous “East Asian growth model.”

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## Tables/Figures

Table 1 GHG-related output 2000-2008 by country

### Patents

Rank	Country	Total patents
1	US	544
2	JP	173
3	CA	68
4	FR	51
5	DE	48
6	UK	21
7	KR	19
8	TW	18
9	AU	16
10	IT	16
11	CH	12
12	NO	11
13	NL	9
14	SE	9
15	CN	8
16	BE	5
17	FI	4
18	IL	4
19	DK	3
20	LI	3
21	VG	3
22	HK	3
23	ES	3
24	IN	2
25	LU	2
26	AN	1
27	RU	1
28	NZ	1
29	VN	1
30	SI	1

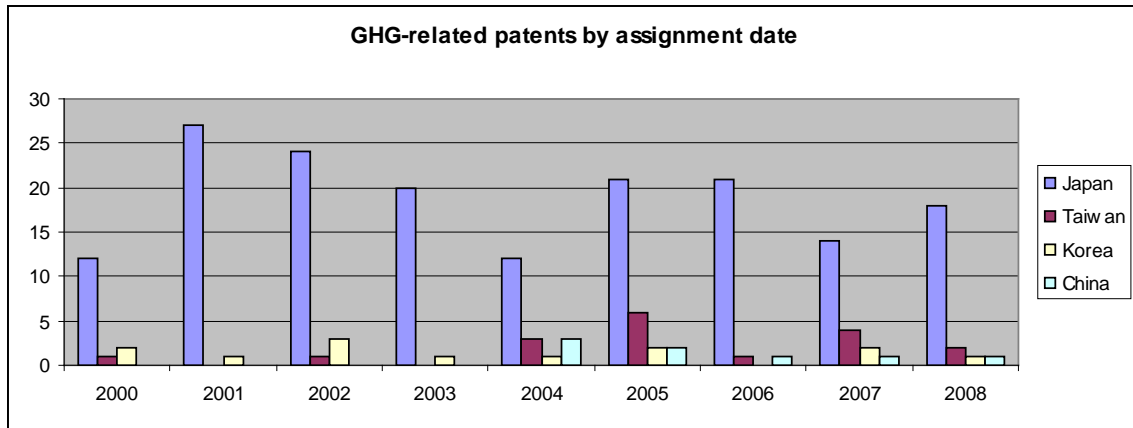
### Publications

Rank	Country	Total patents
1	US	1500
2	UK	587
3	CA	505
4	DE	442
5	AU	296
4	NL	239
7	JP	235
8	FR	231
9	CN	208
10	IT	158
11	SE	147
12	CH	144
13	IN	103
14	DK	99
15	FI	97
16	BR	91
17	RU	89
18	BE	86
19	ES	86
20	AT	82
21	NZ	73
22	TW	58
23	TR	48
24	PL	40
25	KR	35
26	MX	32
27	TH	27
28	GR	24
29	ID	21
30	PT	21

Source: USPTO (2009), Web of Science (2009).

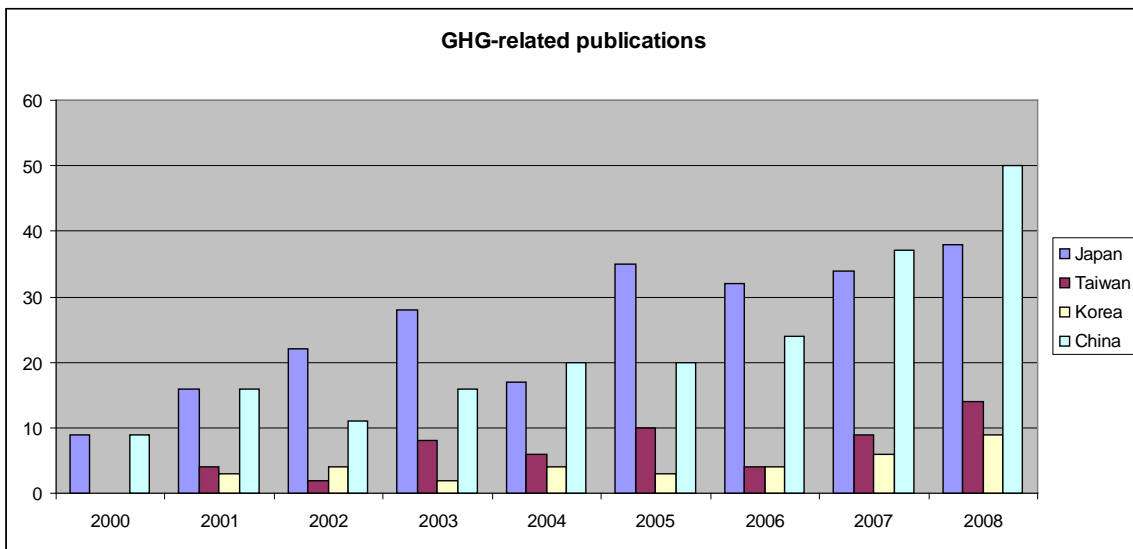
Note: Country code abbreviations are listed in the appendix.

Fig. 1 GHG-related patents by assignment date



Source: Author's calculations using USPTO (2008) data.

Fig. 2 GHG-related publications



Source: Author's calculations using Web of Science (2009) data.

Fig. 3 GHG-based patent breakdown by research entity

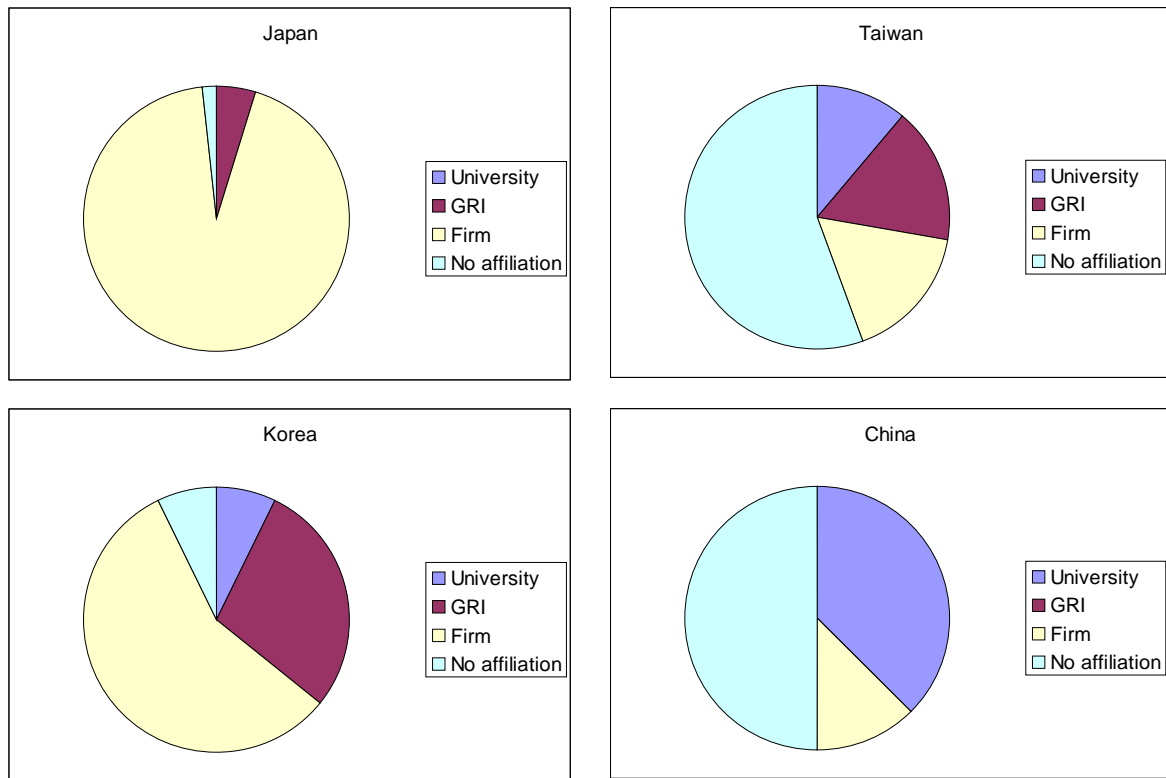
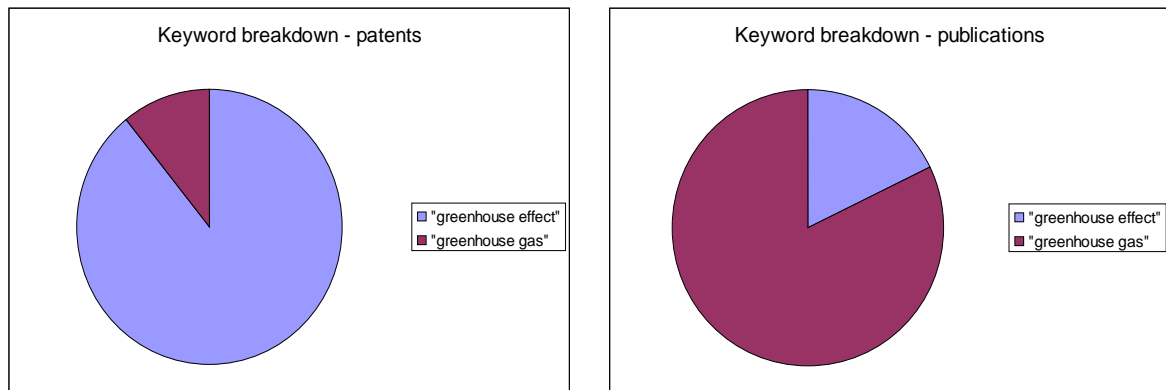


Fig. 4 Keyword breakdown for East Asian research output



Source: Based on author's calculations using USPTO (2009) and Web of Science (2009) data.

Table 2 Source of existing APPCDC agreements for select countries

	Japan	Korea	China
Aluminum Task Force	ATF.06.06		ATF.06.02
Buildings & Appliances Task Force	BATF.06.03	BATF.06.01 BATF.06.06	BATF.06.04 BATF.06.07
Cleaner Fossil Energy Task Force	CFE.06.07	CFE.07.16	
Cross Cutting & Other			CCO.07.04
Coal Mining Task Force			CLM.06.11 CLM.06.12 CLM.06.16
Cement Task Force	CMT.06.01 CMT.06.02 CMT.07.10	CMT.07.09	CMT.06.05
Power Generation & Transmission Task Force			PGT.06.12
Renewable Energy & Distributed Generated Task Force	RDG.06.15 RDG.06.16	RDG.06.04 RDG.06.11 RDG.06.17 RDG.06.24	RDG.06.05 RDG.08.33 RDG.08.34 RDG.08.35
Steel Task Force	STF.06.02	STF.06.03	STF.06.04

Source: Asia-Pacific Partnership (2009).

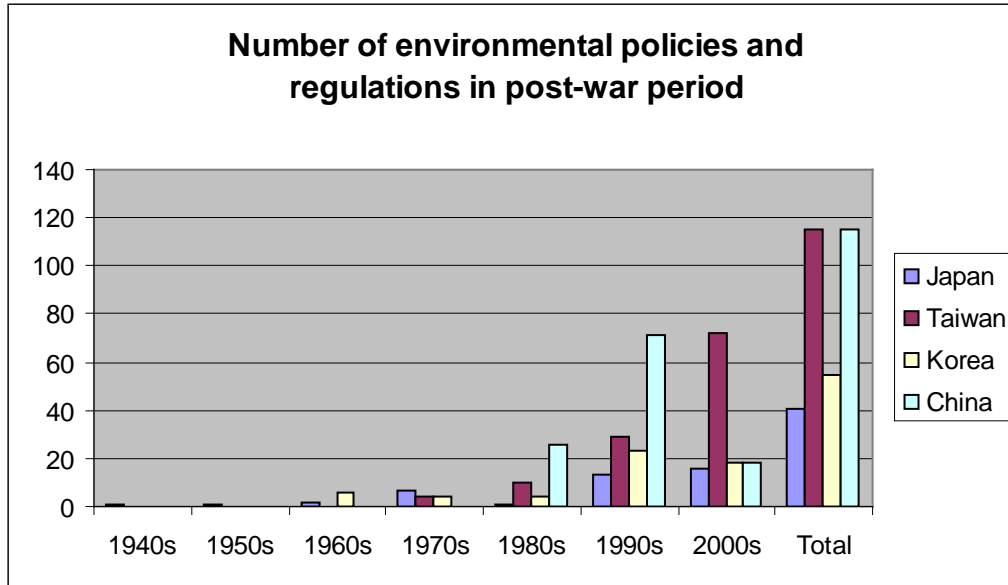
Fig. 5 APPCDC projects in East Asia



Source: <http://data.mapchannels.com/embed/appprojects.htm>



Fig. 6 Number of environmental policies and regulations in post-war period



Source: See notes at end of Appendix.

Table 3 Keyword analysis of East Asian environmental policies

(a) "Pollution"

	Japan	Taiwan	Korea	China
1960s	1	2	1	0
1970s	2	0	0	0
1980s	0	0	1	6
1990s	0	4	0	13
2000s	0	24	0	4

(b) "Waste"

	Japan	Taiwan	Korea	China
1960s	0	0	1	0
1970s	1	1	2	0
1980s	0	1	1	2
1990s	0	4	3	6
2000s	2	9	1	3

## Appendix

### Country abbreviations

Australia	AU	Luxemburg	LU
Austria	AT	Mexico	MX
Belgium	BE	Netherlands	NL
Bosnia/Herzegovina	BA	New Zealand	NZ
Canada	CA	Norway	NO
China	CN	Poland	PL
Czech Republic	CZ	Portugal	PT
Denmark	DK	Romania	RO
Finland	FI	Russia	RU
France	FR	Singapore	SG
Germany	DE	Slovakia	SK
Greece	GR	Slovenia	SI
Hong Kong	HK	South Africa	ZA
Hungary	HU	Spain	ES
Iceland	IL	Sweden	SE
Ireland	IE	Switzerland	CH
Israel	IS	Taiwan	TW
Italy	IT	Thailand	TH
Japan	JP	Turkey	TR
Korea	KR	United Kingdom	UK
Lichtenstein	LI	United States	US

### Environmental policies for the East Asian countries in the post-war era

Country	Decade	Policy name
Japan	1940s	Agricultural Chemicals Regulation Law
	1950s	Natural Parks Law
	1960s	Noise Regulation Law
		Air Pollution Control Law
	1970s	Act on Welfare and Management of Animals
		Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture
		Agricultural Land Soil Pollution Prevention Law
		Water Pollution Control Law
		Vibration Regulation Law
		Offensive Odor Control Law
		Waste Management and Public Cleansing Law
	1980s	Law Concerning the Protection of the Ozone Layer Through the Control of Specified Substances and other Measures
		1990s

		<p>Substances and Promoting Improvements in Their Management</p> <p>Law Concerning Special Measures against Dioxins</p> <p>Systematic Diagram of Automobile NOx Law</p> <p>The Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Automobiles in Specified Areas</p> <p>Law for the Promotion of Sorted Collection and Recycling of Containers and Packaging</p> <p>Law for the Recycling of Specified Kinds of Home Appliances (Home Appliance Recycling Law)</p> <p>Law relating to Protection of the Environment in Antarctica Law</p> <p>Summary of Japan's Law concerning the Recovery and Destruction of Fluorocarbons (Fluorocarbons Recovery and Destruction Law)</p> <p>Japan's Domestic Efforts to Follow up on the Kyoto Conference</p> <p>Law Concerning the Promotion of the Measures to Cope with Global Warming Law</p> <p>Environmental Impact Assessment Law</p> <p>Law Concerning the Promotion of Business Activities with Environmental Consideration by Specified Corporations, etc., by Facilitating Access to Environmental Information, and Other Measures (Provisional Translation)</p> <p>The Basic Environment Law - Outline</p>
2000s		<p>Law for the Promotion of Nature Restoration</p> <p>Law Concerning the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms</p> <p>Invasive Alien Species Act</p> <p>Law for the Promotion of Nature Restoration</p> <p>Outline of the Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management</p> <p>Soil Contamination Countermeasures Act</p> <p>Bill Partially Amending the Law concerning Special Measures for the Conservation of Lake Water Quality</p> <p>Law for the Promotion of Effective Utilization of Resources</p> <p>The Basic Law for Establishing a Sound Material-Cycle Society</p> <p>Construction Material Recycling Law Construction Material Recycling Law</p> <p>Law for the Recycling of End-of-Life Vehicles (End-of-Life Vehicle Recycling Law)</p> <p>Bill Partially Amending the Waste Management and Public Cleansing Law</p> <p>Bill Partially Amending the Waste Management and Public Cleansing Law</p> <p>The Bill on Amendments of the Climate Change Policy</p> <p>Law for Enhancing Motivation on Environmental Conservation and Promoting of Environmental Education Promoting of Environmental Education</p> <p>Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Law on Promoting Green Purchasing)</p>
Taiwan	1970s	<p>Drinking Water Management Act</p> <p>Waste Disposal Act</p> <p>Water Pollution Control Act</p> <p>Air Pollution Control Act</p>
	1980s	<p>Surface Water Classification and Water Quality Standards</p> <p>Organic Act of the Environmental Protection Administration, Executive Yuan</p> <p>Organic Act of the National Institute of Environmental Analysis, Environmental Protection Administration, Executive Yuan</p> <p>Effluent Standards</p> <p>Methods and Facilities Standards for the Storage, Clearance and Disposal of Industrial Waste</p> <p>Noise Control Act Enforcement Rules</p> <p>Noise Control Act</p> <p>Vehicular Air Pollutant Emission Standards</p>

Toxic Chemical Substances Control Act Enforcement Rules  
 Toxic Chemical Substances Control Act  
 1990s Environmental Analysis Organization Management Regulations  
 Organic Act of the Environmental Protection Personnel Training Institute, Environmental Protection Administration, Executive Yuan  
 Soil and Groundwater Pollution Remediation Act  
 Drinking Water Management Act Enforcement Rules  
 Drinking Water Quality Standards  
 Regulations Governing General Waste Recycling, Clearance and Disposal  
 General Waste Clearance and Disposal Fee Collection Regulations  
 Noise Control Standards  
 Waste Incinerator Dioxin Control and Emission Standards  
 Waste Incinerator Air Pollutant Emissions Standards  
 Stationary Pollution Source Air Pollutant Emissions Standards  
 Air Pollution Control and Emissions Standards for the Semiconductor Industry  
 Air Pollution Control Fee Collection Regulations  
 Specific Policy Items Requiring the Conduct of an Environmental Impact Assessment  
 Standards for Determining Specific Items and Scope of Environmental Impact Assessments for Development Activities  
 Environmental Impact Assessment Act Enforcement Rules  
 Environmental Impact Assessment Act  
 Guidelines for Marking of Packaging and Handling Sites and Facilities of Toxic Chemical Substances and Establishment of Materials Safety Data Sheets  
 Toxic Chemical Substances Transportation Management Regulations  
 Toxic Chemical Substances Handling Application Fee Standards  
 Regulations Governing the Employment of Environmental Agent Professional Technicians  
 Pest Control Operators Management Regulations  
 Environmental Agents Control Act Enforcement Rules  
 Environmental Agent Factory Establishment Standards  
 Environmental Agents Control Act  
 Public Nuisance Dispute Mediation Fee Collection Regulations  
 Public Nuisance Dispute Mediation Act Enforcement Rules  
 Public Nuisance Dispute Mediation Act  
 Regulations Governing Signature by Professional Environmental Engineers  
 2000s Basic Environment Act  
 Regulations Governing Collection of Soil and Groundwater Pollution Remediation Fees  
 Regulations Governing the Preliminary Assessment of Soil and Groundwater Pollution Control Sites  
 Remediation Site Scope of Pollution Survey, Environmental Impact Assessment, and Cleanup Priority Ranking Regulations  
 Soil Pollution and Groundwater Pollution Remediation Fund Revenues and Expenditures, Safekeeping, and Utilization Regulations  
 Soil and Groundwater Pollution Control Zone Control Regulations  
 Soil and Groundwater Pollution Remediation Act Enforcement Rules  
 Official Announcement of Enterprises in Article 8, Paragraph 1 of the Soil and Groundwater Pollution Remediation Act  
 Amounts for Ship Pollution Damage Compensation Liability Insurance and Guarantees  
 Major Marine Oil Pollution Emergency Response Plan  
 Disciplinary Citation for a Violation of the Marine Pollution Control Act  
 Directions for the Application for Passage by Foreign Vessels Transporting Hazardous Substances Through the Seas of the R.O.C.  
 Regulations Governing the Collection of Various Marine Pollution Control Permit

Application Fees  
Regulations Governing Marine Environment Pollution Cleanup and Disposal  
Marine Pollution Control Act Enforcement Rules  
Marine Dumping and Marine Incineration Management Regulations  
Marine Pollution Control Act  
Official Announcement of Determination of the Water Pollution Control Act Industry Classifications and Definitions  
Water Pollution Control Measures and Test Reporting Management Regulations  
Water Pollution Control Act Enforcement Rules  
Soil Treatment Standards  
Regulations Governing Water Pollution Control Measure Plans and Permit Application Review  
Excessive Product Packaging Restrictions  
Resource Recycling Act Enforcement Rules  
Renewable Resource Reuse Management Regulations  
Management Regulations for the Restriction or Prohibition of the Import or Export of Renewable Resources  
Management Regulations for Recycling Enterprises Handling Recyclable Waste  
First Batch of Environmentally Preferable Product Items Requiring Preferential Procurement by Government Agencies, Public Schools, Public Enterprises and Organizations, and Military Authorities  
EPA Renewable Resource Recovery Management Regulations  
Resource Recycling Act  
Types of Industrial Waste Required as Materials for Industrial Use  
The Responsibility of Manufacturers and Importers with Regards to the Recycling, Clearance, and Disposal of Articles and Containers, and the Scope of Responsibility of Enterprises with Regards to Recycling, Clearance, and Disposal  
Scope of Enterprises Responsible for Marking Relevant Recycling Labels on Goods and Containers, Size and Locations of Label Designs, and Other Binding Matters for Recycling Labels  
Scope of Container and Dry Battery Vendors Required to Install Resource Recycling Facilities, Facility Installation, Specifications and Other Binding Matters  
Restrictions on the Use of Plastic Trays and Packaging Boxes  
Restrictions on the Manufacture, Import, and Sale of Dry Cell Batteries  
Restriction of the Import and Sale of Mercury Thermometers  
Official Announcement of Fee Rates for Article and Container Recycling, Clearance, and Disposal  
Waste Disposal Act Enforcement Rules  
Standards for Defining Hazardous Industrial Waste  
Responsible Enterprise Regulated Recyclable Waste Management Regulations  
Regulated Recyclable Waste Auditing and Certification Regulations  
Permit Management Regulations for Public or Private Waste Clearance and Disposal Organizations  
Management Regulations for the Import, Export, Transit and Transshipment of Waste  
Regulations Governing the Issuance and Replacement of Compliance Certification and Sample Testing for New Vehicle Model Noise Inspections  
Motor Vehicle Noise Control Regulations  
Civil Aircraft Noise Control Standards  
Fee Rates for Stationary Pollution Source Air Pollution Control  
Steelmaking Industry Electric Arc Furnace Dioxin Control and Emission Standards  
Steel Industry Sintering Plant Dioxin Control and Emission Standards  
Stationary Pollution Source Installation and Operating Permit Management Regulations  
Standards for the Composition and Properties of Automobile Gasoline and Diesel Fuels

Small and Medium-Sized Waste Incinerator Dioxin Control and Emission Standards  
 Regulations Governing the Certification and Authorization of Imported Motor Vehicle Air Pollutants  
 Regulations Governing Verification Issuance and Cancellation of Certification Compliance for Motorized Bicycle Configuration Emissions  
 Regulations Governing Issuance, Revocation, and Cancellation of Compliance Certification for Gasoline and Alternative Clean Fuel Engine Vehicle Emissions Inspections  
 Regulations Governing Issuance, Revocation, and Cancellation of Compliance Certification for Diesel and Alternative Clean Fuel Engine Vehicle Emissions Inspections  
 Optoelectronic Material and Element Manufacturing Industry Air Pollution Control and Emission Standards  
 In-Use Motor Vehicle Recall and Correction Regulations  
 Gas Station Gasoline Vapor Recovery Facility Management Regulations  
 Dioxin Emission Standards for Stationary Pollution Sources  
 Air Pollution Control Act Enforcement Rules  
 Regulations Governing Government Policies on Environmental Impact Assessment Handling Management Including Restricted Uses for Toxic Chemical Substances such as Polychlorinated Biphenyls as Announced in the List of 161 Regulatory Control Numbers  
 Toxic Chemical Substances Hazard Prevention and Response Plan Regulations  
 Toxic Chemical Substances Accident Investigation and Disposal Report Operating Standards  
 Toxic Chemical Substance Handling Liability Insurance Regulations  
 Working Standards for Environmental Agent Permit Application and Issuance  
 Regulations for Environmental Agent Vendor and Pest Control Operator Permit Application and Issuance  
 Fee Collection Standards for Environmental Agents Permission Applications and Testing  
 Regulations Governing Takeover of Operation of Environmental Pollution Control Facility with Private Participation in Infrastructure Projects  
 Analysis Permit Application Fee Collection Standards

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Korea	1960s	Environmental Pollution Prevention Act Act Relating to the Protection of Birds, Mammals & Hunting Act Relating to Toxic & Hazardous Substances Waste Cleaning Act Sewerage Act Water Supply & Waterworks Installation Act
	1970s	Environmental Conservation Act Natural Park Act Waste Control Act
	1980s	Compound Waste Treatment Corporation Act Environmental Pollution Prevention Corporation Act Natural Park Act Environmental Management Corporation Act Wastes Control Act
	1990s	Framework Act on Environmental Policy Clean Air Conservation Act Indoor Air Quality Control in Public Use Facilities, etc. Act Noise & Vibration Control Act Water Quality and Ecosystem Conservation Act Act Relating to the Han River Water Quality Improvement & Community Support Natural Environment Conservation Act Act on Special Measures for the Control of Environmental Offenses

		<p>Environmental Dispute Adjustment Act</p> <p>Environment Improvement Expenses Liability Act</p> <p>Special Act on the Ecosystem Conservation of Small Islands such as Dokdo Island</p> <p>Wetland Conservation Act (jointly enacted)</p> <p>Environmental Impact Assessment Act</p> <p>Soil Environment Conservation Act</p> <p>Act Relating to Special Accounting for Environmental Improvement</p> <p>Development of &amp; Support for Environmental Technology Act</p> <p>Toxic Chemicals Control Act</p> <p>Act on the Disposal of Sewage, Excreta &amp; Livestock Wastewater</p> <p>Act on the Promotion of Saving and Recycling of Resources</p> <p>Act on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal</p> <p>Promotion of Installation of Waste Disposal Facilities and Assistance, etc. to Adjacent Areas Act</p> <p>Korea Environment &amp; Resources Corporation Act</p> <p>Management of Drinking Water Act</p>
2000s		<p>Framework Act on Sustainable Development</p> <p>Environmental Education Promotion Act</p> <p>Environmental Health Act</p> <p>Foul Odor Prevention Act</p> <p>Special Act on Metropolitan Air Quality Improvement</p> <p>Act on the Nakdong River Watershed Management &amp; Community Support</p> <p>Act on the Geum River Watershed Management &amp; Community Support</p> <p>Act on the Yeongsan &amp; Sumjin River Watershed Management &amp; Community Support</p> <p>Act on Antarctic Activities and Environmental Protection (jointly enacted)</p> <p>Act on Promotion of the Purchase of Environment-Friendly Products</p> <p>Act on Environmental Test and Examination</p> <p>Act on the Protection of the Baekdu Daegan Mountain System (jointly enacted)</p> <p>National Trust Act on Cultural Heritage &amp; Natural Environment Assets (jointly enacted)</p> <p>Wildlife Protection Act</p> <p>Act on the Management and Use of Livestock Manure (jointly enacted)</p> <p>Act on Resource Recycling of Electrical and Electronic Equipment and Vehicles (jointly enacted)</p> <p>Act on the Promotion of Construction Waste Recycling</p> <p>Sudokwon Landfill Site Management Corporation Act</p>
China	1980s	<p>Environmental Protection Law of the People's Republic of China</p> <p>Law of the People's Republic of China on Prevention and Control of Water Pollution</p> <p>Constitution of the People's Republic of China (excerpts of environment-related articles)</p> <p>Marine Environment Protection Law of the People's Republic of China</p> <p>City Planning Law of the People's Republic of China</p> <p>Law of the People's Republic of China on the Protection of Wildlife</p> <p>Land Administration Law of the People's Republic of China</p> <p>Mineral Resources Law of the People's Republic of China</p> <p>Fisheries Law of the People's Republic of China</p> <p>Grassland Law of the People's Republic of China</p> <p>Forestry Law of the People's Republic of China</p> <p>Law of the People's Republic of China on the Protection of Cultural Relics</p> <p>Circular on the Jurisdiction to Examine and Approve the Environmental Impact Statement of Construction Projects</p> <p>Provisions on Engineering Design of Environmental Protection of Construction Projects</p> <p>Regulations on the Administration of National Environmental Monitoring</p>

Interim Measures on the Collection of Pollution Discharge Fee  
 Interim Measures on the Special Fund for Control of Pollution Source  
 Interim Measures on Reporting Environmental Pollution and Damage Accidents  
 A Circular Decree of the State Council Concerning Strict Protection of Precious and Rare Wild Animals  
 Measures on the Management of Urban Radioactive Wastes  
 Regulations on the Administration of Environmental Protection in the Exploration and Development of Offshore Petroleum  
 Regulations on the Prevention of Vessel - induced Sea Pollution  
 Regulations on Control over Dumping of Wastes in the Ocean  
 Interim Measures on the Management of Water Pollutants Discharge Permit  
 Measures on the Supervision of Sewage Treatment Facilities for Environmental Protection  
 Provisions on the Administration of the Prevention and Control of Pollution in Protected Areas for Drinking Water Sources  
 1990s **Law of the People's Republic of China on Prevention and Control of Pollution From Environmental Noise**  
 Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste  
 Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution  
 Interim Regulations on the Prevention of Water Pollution in the Huai River Valley  
 Meteorology Law of the People's Republic of China  
 Administrative Reconsideration Law of the People's Republic of China  
 Law on the Exclusive Economic Zone and the Continental Shelf of the People's Republic of China  
 Fire Control Law of the People's Republic of China  
 Law of the People's Republic of China on Protecting Against and Mitigating Earthquake Disasters  
 Law of the People's Republic of China on Conserving Energy  
 Construction Law of the People's Republic of China  
 Flood Control Law of the People's Republic of China  
 Highway law of the People's Republic of China  
 Law of the People's Republic of China on Township Enterprises  
 Law of the People's Republic of China on the Coal Industry  
 Electric Power Law of the People's Republic of China  
 Law of the People's Republic of China on State Compensation  
 Foreign Trade Law of the People's Republic of China  
 Law of the People's Republic of China on the Territorial Sea and the Contiguous Zone  
 Law of People's Republic of China on the Entry and Exit Animal and Plant Quarantine  
 Law of the People's Republic of China on Water and Soil Conservation  
 Railway Law of the People's Republic of China  
 Circular Concerning the Promulgation of Items and Standards Concerning the Collection of Administrative Fees in Environmental Protection Field  
 Circular on Carrying out Nationwide Report and Registration of Pollutant Discharges  
 Circular on Standardizing Pollutant Outlets  
 Procedures on the Administration of Environmental Protection of Construction Projects  
 Circular on Management of Foreign - Invested Construction Projects  
 Circular on Strengthening EIA Management of Construction Projects Financed by International Financial Organizations  
 Provisions on the Management of Inspection and Acceptance of Completed Environmental Protection Facilities of Construction Projects  
 Circular on Strengthening Environmental Management of Catering, Entertainment and Service Enterprises



Provisions on Strengthening Environmental Protection of Township Enterprises  
 Regulations on Environmental Management of Construction Project  
 Measures on the Management of Qualification Certificates for Construction Project  
 Environmental Impact Assessments  
 Circular on Strengthening the Management of Hazardous Chemicals  
 Circular on Strengthening the Control over Noise Pollution from Daily Life  
 Circular of the General Office of the State Council on the Strict Control on Transboundary  
 Movements of Foreign Waste to China  
 Industrial Policy on Automobile  
 Circular on Publishing the First Catalogue of the Eliminated Technologies and Equipment  
 Causing Serious Air Pollution  
 Official Reply of the State Council Concerning Acid Rain Control Zones and Sulphur  
 Dioxide Pollution Control Zones  
 Circular on Strengthening the Supervision and Administration of Pollution by Exhaust  
 from Newly Manufactured Motor Vehicles  
 Circular on Related Issues Concerning Installing Pollution Control Products on Motor  
 Vehicles  
 Circular on Adjusting the Standard on the Elimination of Light Trucks  
 Circular of the General Office of the State Council on Limiting and Stopping the  
 Production, sales and Use of Leaded Fuel  
 Technical Policy on the Prevention and Control of Pollution by Motor Vehicle Emissions  
 Circular on Strengthening the Collection of the Sewage Treatment Fee and Establishing a  
 Sound Operational Mechanism for Urban Sewage Discharge and Centralized Treatment  
 Circular on Issues Concerning Experimental Collecting of Urban Sewage Treatment Fee in  
 the Huaihe River Valley  
 Decision of the State Council on Several Issues Concerning Environmental Protection  
 Decision of the State Council on Implementing Scientific Outlook on Development and  
 Strengthening Environmental Protection  
 Measures on Supervision of Exhaust Pollution from Automobiles  
 Regulations on Emergency Measures for Nuclear Accidents at Nuclear Power Plants  
 Measures on the Management of Environmental Standards  
 Measures on the Administration of Pollution Sources Monitoring  
 Measures on the Management of Certificates for Environmental Engineering Design  
 Measures on Qualification Authentication for Operating Environmental Protection  
 Facilities (on Trial)  
 Measures on the Certification Management of Products Bearing Environmental Labels  
 Provisions on the Administration of Qualification Authentication of the Inspection  
 Institutions for Environmental Protection Products  
 Provisions on the Administration of Report and Registration of Pollutants Discharge  
 Measures on Administrative Penalty for Environmental Protection  
 Measures on the Administration of Interpretation on Environmental Regulations  
 Regulations for the Implementation of the People's Republic of China on the Protection of  
 Terrestrial Wildlife  
 Regulations of the People's Republic of China on Nature Reserves  
 Regulations of the People's Republic of China on Wild Plants Protection  
 Provisions on the First Import of Chemicals and the Import and Export of Toxic Chemicals  
 Measures on the Management of Radiation Environment  
 Regulations of the People's Republic of China on Nature Reserves  
 Measures on the Management of Electromagnetic Radiation Environmental Protection  
 Regulations on the Prevention of Pollution Damage to the Marine Environment by Land -  
 based Pollutants  
 Interim Provisions on the Administration of Environmental Protection of Waste Imports  
 Supplementary Provisions to the "Interim Provisions on the Administration of

Environmental Protection regarding the Import of Waste Materials  
 Proposals on Strengthening the Management of the Plastic Package Wastes along Main Roads, in River Basins and at Tourist Attractions  
 Measures on Duplicated Form for Transfer of Hazardous Wastes Measures on the Management of Hazardous Waste Manifests

2000s Law of the People's Republic of China on the Promotion of Clean Production  
 Law of the People's Republic of China on Desert Prevention and Transformation  
 Regulations for the Implementation of Forestry Law of the People's Republic of China  
 Circular on Relevant Issues Concerning Monitoring for Inspection and Acceptance of Completed Environmental Protection Facilities of Construction Projects  
 Announcement on the List of Toxic Chemicals Severely Restricted on the Import and Export in China (Circular No. 65 [2005])  
 Announcement on the Catalogue of Commodities Prohibited from Import (The 6th Batch) and the Catalogue of Commodities Prohibited from Export (The 3rd Batch) (Circular No. 116 [2005])  
 Amendment on the List of Toxic Chemicals Severely Restricted on Import and Export in China (Circular No. 80 [2006])  
 Announcement on Releasing Catalogue of Solid Wastes Forbidden to Import  
 Circular on List of Institutes for Identification of Solid Waste Attributes and Identification Procedures  
 Technical Policies for the Municipal Refuse Disposal and the Prevention and Control of Pollution  
 Circular on Reducing Taxation of Consumption Tax on Sedan Cars with Low Pollution Discharge  
 Circular on Adjusting Several Provisions on the Standards on the Elimination of Outdated Automobiles  
 Circular of the State Council on Urban Water Supply, Saving Water and Water Pollution Control  
 Measures on the Administration of the Certification for Organic Foods  
 Measures on the Certification Management of Environmental Protection Products  
 National Catalogue of Hazardous Wastes  
 Implementing Rules on the Law on the Prevention and Control of Water Pollution  
 Regulations on Labor Protection in Workplaces Where Toxic Substances Are Used

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Source: Ministry of the Environment of Japan (2009); Environmental Protection Administration Taiwan (2009); Ministry of the Environment of Korea (2009); Ministry of Environmental Protection PRC (2009)