Master's Thesis of Iwamoto Yasutaka

Threats to Biodiversity and Anthropogenic Pressures

- A Study on Development and Demographic Pressures about Asia based on IUCN-CMP Threats Classification Scheme and Content Analysis of CBD National Reports –

생물다양성에 대한 위협요인과 개발 및 인구 압력과에 관계성 연구

- 아시아 국가를 대상으로 IUCN-CMP 위협요인 분류법과 CBD 국가보고서 내용분석을 실시 -

February 2016

College of Agriculture and Life Sciences

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Forest Environmental Science Major

Yasutaka Iwamoto

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Instructor: Professor Seong-il Kim

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Chair YOUN Yeochang (Seal)

Vice Chair Seongil Kim (Seal)

Examiner Hagyoung Heo (Seal)

Abstract

The conventional approach to maintaining biological biodiversity generally proceeds species by species and threat by threat. This trend seems to continue even today. Although efforts have been put to show threats to biodiversity in organized manners, mostly represented by IUCN (International Union for Conservation of Nature)-CMP (Conservation Measurement Partnership) Threats Classification, research about what causes the threats (“root causes”) is not really available to date in a holistic way.

Threats to biodiversity include nature- and human-induced ones. It is a common recognition that biodiversity is threatened mainly by human activities. A lot of studies talk about impact of anthropogenic pressures such as development and demographic ones to biodiversity. However, to the author’s knowledge, little research is available on what the root causes on the human-induced threats are, largely because quantification of the magnitude of each threat seems to be difficult to be realised regardless of continuous efforts. So, based on the common understanding that threats to biodiversity are due mostly to anthropogenic pressures, this research aims to see if human development and demographic factors (represented in this study by per-capita GNI and

human population growth momentum) can be scientifically said to be the root causes of the threats to biodiversity. This research should also be seen as another trial to quantify magnitude of the threats by means of content analysis on Asian CBD national reports by coding them in terms of classified threats by IUCN-CMP with codes established based on the elements of which each threat consists. After all this, one would become able to analyze the root causes.

As a result, the following five factors have turned out to be the root causes of human-induced threats to biodiversity, namely, natural resource exploitation, tourism, oil and gas production, urbanization, and commercial and industrial area development. The major finding of the research is that oil and gas production seems also to play an important role in defining root causes of the threats to biodiversity. Unfortunately, the study could not clearly prove that neither per-capita GNI or human population growth pressure are related with the human-induced threats to biodiversity except for per-capita GNI with housing and urban area development, air and water pollution, and population pressure with hunting. However, at least it can be said that those countries expecting further economic growth should be prepared to mitigate threats from housing

and urban area development and industrial water and air pollution. Countries with high population growth should focus on mitigation of hunting.

Having been said all this, however, many of the Asian countries have faced severe lack of resources, both financial and human. In some countries, capacities for surveying and monitoring biodiversity, establishment and management of nature reserves and restoration of biodiversity are still very weak. Also, funds are seriously inadequate. Due to inadequate law enforcement conditions and lack of adequate infrastructure or equipment, too, in some sites, relevant laws cannot be enforced Further research is needed here to suggest to the conservation policy makers how they should better deal with such lack of resources.

Keyword:

Threats to biodiversity, anthropogenic pressures, IUCN-CMP threats classification scheme, Asia, content analysis of CBD national reports

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Content

List of Abbreviations

CBD	Convention on Biological Diversity
CMP	Conservation Measurement Partnership
GNI	Gross National Income
IUCN	International Union for Conservation of Nature
PA	Protected Area
PAME	Protected Area Management Effectiveness
TILCEPA	Theme on Indigenous Peoples and Local Communities, Equity and Protected Areas

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1. Introduction

1.1 Research Background

1.1.1 Threats to Biodiversity and Threats Classification Efforts

Biodiversity has always faced a variety of threats, both nature- and human-induced ones. It is crucial to know what types of threats to biodiversity are present when establishing measures to deal with them. Salafsky et al. (2008) discusses that there are largely two types of threats: indirect and direct threats. Indirect threats are those "factors with a negative effect, such as market demand for fish" that cause direct threats to biodiversity (p.3, (N. Salafsky et al., 2008)), in this case, over-fishing.

A lot of individual researchers and institutions independently put remarkable efforts to set a standard classification of such direct threats to biodiversity. To raise some examples, Salafsky et al. (2002) emphasized the importance of and presented a model for such a classification (Nick Salafsky, Margoluis, Redford, & Robinson, 2002). The Conservation Measurement Partnership (CMP) published its Open Standards for the

Practice of Conservation in 2004 (CMP, 2004). The International Union for Conservation of Nature (IUCN) launched its Threats Authority File Version 2.1 in 2005 (IUCN, 2005). As a result of all these efforts, we have today the threats classification scheme (version 3.1) created by the alliance of IUCN and CMP (IUCN, 2012). The scheme has been widely accepted by the conservation community. For example, it was employed for the European and global studies on the protected area management effectiveness (PAME) launched between 2008 and 2010 ((Leverington et al., 2010; Leverington, Hockings, & Costa, 2008; Nolte et al., 2010)).

There are plenty of studies on each of those direct threats to biodiversity included in the classification scheme, but most of them merely talks about some (not necessarily substantial) means to mitigate the direct threats (Bax, Williamson, Aguero, Gonzalez, & Geeves, 2003). The conventional approach to maintaining biological biodiversity generally proceeds species by species and threat by threat (Scott et al., 1993). They do not really discuss the "root causes (p.15, (Hockings, Stolton, Leverington, Dudley, & Courrau, 2006))" that create those direct threats. This trend seems to continue even

today as a recent study demonstrates in their aggregate of studies about effects of land use on local terrestrial biodiversity (Newbold et al., 2015). Those root causes are one of the two issues that the second PAME global study says we need more research (the other one is the “inter-relationships between the threats”) (p.42, (Leverington et al., 2010)). Some studies look at potential root causes such as population growth (Jha & Bawa, 2006; McKee, Sciulli, Fooce, & Waite, 2004) or urbanization (Hansen et al., 2005; Mcdonald, Kareiva, & Forman, 2008). However, to our knowledge, there has been no thorough research on a group of such potential root causes. If we look back at the history of the research on threats to biodiversity, we will see more clearly that it is a reasonable statement. Since threats to biodiversity have been heavily studied in relation to protected areas (PAs) and their management effectiveness in particular, here is the history of studies on threats to PAs.

1.1.2 Previous Studies on Threats to Biodiversity (in Context of Protected Areas)

Up until 1980’s, the conservation community did not pay as much attention as they do

today to the effectiveness of PAs when IUCN chose the world's 43 most threatened PAs and analyzed them for the first time of its kind of research (IUCN, 1984). The top ten threats indicated in the report are: inadequate management resources, human encroachment, change in water regime or hydro development, poaching, adjacent land development, inappropriate internal development (eg roads), mining and prospecting, livestock conflicts, military activity, and forestry activities ((Hockings et al., 2006), p.16). If we compare them to the most recently reported global threats to PAs, we can see some constant trend of the kinds of threats present to the PAs. The newest ones are: biological resource use, agriculture and aquaculture, human intrusions and disturbance, natural system modifications, development on protected areas, mining, quarrying and oil drilling, pollution of various kinds, invasive species, fragmentation caused by roads and other utility lines, and severe weather and climate change ((Leverington et al., 2010), pp.41-42). As Table 1 shows, in both reports most of threats to PAs are those induced by human beings. A report published by IUCN and TILCEPA (Theme on Indigenous Peoples and Local Communities, Equity and Protected Areas)[1] in 2010

[1] A constituency of the IUCN CEESP-WCPA cluster. CEESP stands for the Commission on Environmental, Economic and Social Policy and is one of the six committees of IUCN. WCPA is another IUCN committee and means the World Commission on Protected Areas.

supports this, stating that “biodiversity is primarily threatened by human behaviour ((IUCN-TILCEPA, 2010), p.4).” What can be observed here in Table 1 is that threats to PAs have not really changed over 30 years. Even though we do not see certain items that are in one column but not in the other, they are either the threats that have still been discussed but not ranked as high as before (i.e., “Inadequate management resources”) (Gubbay, 1995; White, Courtney, & Salamanca, 2002) or the threats that have recently attracted more and more attention (i.e., “Pollution of various kinds (Agardy et al., 2003),” “Invasive species (Bax et al., 2003; Pauchard & Alaback, 2004),” and “Severe weather and climate change (Dunlop & Brown, 2008; Hannah et al., 2007)”).

Table 1: Threats to Protected Areas in 1984 and 2010

10 Top Threats to PAs Reported in 1984	**10 Top Threats to PAs Reported in 2010**
Inadequate management resources	N/A
Human encroachment	Human intrusions and disturbance
Change in water regime or hydro development	Natural system modifications
Poaching	Biological resource use
Adjacent land development	Development on protected areas
Inappropriate internal development (eg roads)	Fragmentation caused by roads and other utility lines
Mining and prospecting	Mining, quarrying and oil drilling
Livestock conflicts	Agriculture and acquaculture
Military activity	Human intrusions and disturbance
forestry activities	Biological resource use

N/A	Pollution of various kinds
N/A	Invasive species
N/A	Severe weather and climate change

A consequent study in 1985 (Machlis & Tichnell, 1985) that targeted 135 PAs in more than 50 countries reported pretty much the same, except for soil erosion, local attitudes and fire. Just being unranked on the latest top ten threats list does not lower the importance of them as threats to PAs. Soil erosion (Maikhuri et al., 2000), local attitudes (Maikhuri et al., 2000) and fire (Nepstad et al., 2006; Parr & Brockett, 2008) have been discussed a lot as well. The 80's experienced active research on threats to PAs in a wide scale. The same year, IUCN published a report (Amend & Amend, 1995) on the relationship between national parks and local community in South America in which 148 national parks are analyzed for their principal problems ((Hockings et al., 2006), p.16). This research discusses legal and land tenure issues and poor park planning, apart from the threats to PAs already recognized at that time. The results from the analysis on the threats to PAs in Latin America and Caribbean (LAC)

published in 2010 supports that LAC tends to have larger degree of threats related to housing and settlements within PA than other regions in the world (Africa, Asia, Europe and Oceania) ((Leverington et al., 2010), p.43). Ten years after IUCN's first research on threats to PAs at the international level, the organization conducted a regional survey of PAs targeting WCPA members and other PA professionals ((Hockings et al., 2006), p.16). The survey revealed that absences of political will, tourism impacts and impact from adjacent land use were also some of the important threats to PAs worth consideration. However, as we can observe from all these past researches, little study on the causes of the reported threats has been available.

1.1.3 Importance of Study on Relationship between Threats to Biodiversity and Socio-Economic Factors

Since biodiversity is mostly threatened by human activities (p.4, (IUCN-TILCEPA, 2010)), and it should be easier to make countermeasures against human-induced direct threats that are predictable to a larger extent, rather than to come up with those against nature-induced direct threats (e.g., geological events including volcano eruptions,

earthquakes, tsunamis, avalanches, or landslides), root causes to human-induced direct threats to biodiversity should be studied more intensely. Naturally, most of those root causes to human-induced direct threats to biodiversity are socio-economic subjects, such as degree of economic development measured through GDP, to raise an example, demographic pressure, etc.

The issue is whether degrees of the socio-economic factors influence the magnitudes of direct threats to biodiversity. It seems intuitively sound to state that different degrees of socio-economic factors will bring distinct magnitudes of direct threats to biodiversity. For example, a country with a high human population density can have more threat types related to human intrusions and disturbance in comparison with another nation with lower population density. However, as far as the magnitudes of direct threats to biodiversity and a variety of socio-economic factors are concerned, research dealing with the relationship between them is little available at any one of the global, national, state/provincial, local, and site levels.

By the way, before getting into details, we would like to clarify what we really mean when talking about "biodiversity." The original form of the term "biodiversity" is "biological diversity," a term introduced in 1968 to advocate conservation (Hannah et al., 2007). More than a decade later, a book introduced the term to the scientific community (Bax et al., 2003). Then, the term "'[b]iodiversity' was coined as a contraction of "biological diversity" in 1985, but the new term arguably has taken on a meaning and import all its own. A symposium in 1986, and the follow-up book *BioDiversity* (Machlis & Tichnell, 1985), edited by biologist E. O. Wilson, heralded the popularity of this concept."[2] According to the United Nations Convention on Biological Diversity (CBD), "'[b]iological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."[3]

[2] Biodiversity. Online. Stanford encyclopedia of philosophy. Retrieved November 4, 2012 from http://plato.stanford.edu/entries/biodiversity/

[3] Article 2. Use of Terms. Online. Convention on Biological Diversity. Retrieved on November 4, 2012 from http://www.cbd.int/convention/articles/?a=cbd-02

1.2 Research Objective

This research intends to observe whether anthropogenic pressures such as development and demographic pressures can be scientifically said to be the major “root causes” of the threats to biodiversity. The research should be seen as another trial to provide a way to quantify the magnitudes of the threats that have not been made standardized or available for use, although intents for such quantification exist, using height changes of plants from the closest road by species and by site (Newbold et al., 2015), or species richness by country with different human population density (McKee et al., 2004), to rise some examples. A PAME European study (Nolte et al., 2010) also gave it a chance to calculate such magnitudes in a simple manner by aggregating the numbers of threats reported in PAME assessment papers in the world (p.40, (Leverington et al., 2010)), but the study does not seem profoundly to deal with the magnitudes (see p.36, (Nolte et al., 2010)). Probably, one of the best examples of the intention to provide the measurement of such severity is the IUCN Red List of Threatened Species. Still, we do not clearly see to what extent the threats listed in the IUCN-CMP classification scheme affect those species. Without establishing a standard tool to measure the severity of the

threats, it would be also very hard to discuss the inter-relationships between the threats mentioned earlier. Hoping that further studies for a standardized means to measure the magnitudes of the threats to biodiversity will be established, this paper aims mostly to deal with the relationship between the magnitudes of the threats to biodiversity and the anthropogenic pressures. By knowing how they are related, conservation policy makers might be able to make a better allocation of budget to tackle the threats by taking into account the surrounding development and demographic conditions.

1. Methodology

2.1 Geographical Scope of the Research

In order to observe how the potential root causes to the human-induced direct threats to biodiversity that are similar in meaning to socio-economic factors are related with the types of the direct threats to biodiversity at the national level, perhaps Asia should be chosen as one of the best regions in the world. The Convention on Biological Diversity (CBD)'s Asia except for Uzbekistan is basically what it is meant to be called Asia in the research. The CBD's Asia consists of 29 countries, but for information accessibility

reason[4], Uzbekistan is omitted from the geographical research scope. Therefore, a total of 28 countries are what the term "Asia" means in the research.

Calculated based on the International Monetary Fund (IMF)'s World Economic Outlook Database (WEOD) October 2012 edition[5], Asia's gross domestic product (GDP) based on purchasing-power-parity (PPP) in 2010 accounts for 33.70% of the world's total, exceeding one third, without information of Democratic People's Republic of Korea (DPRK) and with data for Bhutan and Maldives estimated by IMF (0.005% and 0.003%, respectively). Based on the same source, IMF estimates that Asia's PPP-based GDP will be 38.88% by 2017, predicting a firm growth which will certainly bring more impact on biodiversity in the Region.[6]

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[4] As will be mentioned in the next section, the research is based on the data collected from CBD's latest national reports. Uzbekistan's report does exist, but is inaccessible by the author as it is in Russian.

[5] http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/weorept.aspx?pr.x=56&pr.y=5&sy=2010&ey=2017&scsm=1&ssd=1&sort=country&ds=.&br=1&c=512%2C548%2C556%2C513%2C948%2C514%2C518%2C516%2C558%2C522%2C564%2C924%2C566%2C576%2C524%2C528%2C578%2C537%2C534%2C536%2C925%2C158%2C916%2C542%2C582%2C917%2C544&s=PPPSH&grp=0&a=

[6] By the way, why has PPP based GDP been chosen here? According to the Organization for Economic Co-operation and Development (OECD), PPPs are the rates of currency conversion that equalize the purchasing power of different currencies by eliminating the differences in price levels between countries (OECD, 2013). Therefore, PPP-based GDP allows us to more accurately measure the extent to which a country's GDP can buy in comparison with that of another country, which will influence the amount of goods to be produced. In other words, PPP-based figures are better for the purpose of international comparison.

As for Asia's share in the world's landmass, calculated based on the World Bank (WB)'s dataset[7], Asia accounts for 18.47% of the total global terrestrial surface. Asia shares 55.04% of the world population in 2011, according to calculation based on WB's dataset[8]. There are 193 United Nations (UN) member countries today.[9] So, just imagine that the 28 Asian countries out of the 193 states (14.51%) make up more than one third of the world's total GDP and half of the global population, even though they account merely for less than one fifth of the world's landmass.

[7] Surface area (sq. km). Retrieved January 29, 2013 from http://data.worldbank.org/indicator/AG.SRF.TOTL.K2.
[8] Population, total. Retrieved January 29, 2013 from http://data.worldbank.org/indicator/SP.POP.TOTL.
[9] See the following UN https://www.un.org/en/members/.

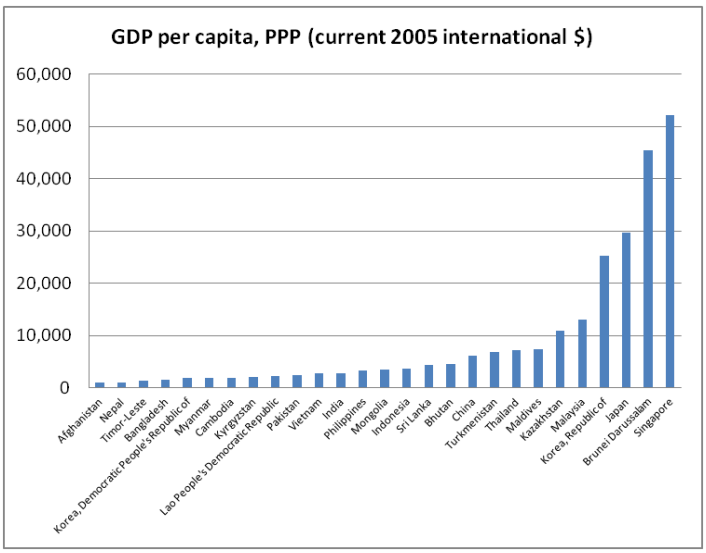

Figure 1: GDP per capita, PPP (current 2005 international $)

This shows that Asia is facing large anthropogenic impact on biodiversity, represented for example by high population density, extensive natural resource use and development pressure. Also, Asia has a fairy diversified economy. As seen in Figure 1, the 28 Asian countries include a variety of GDP per capita figures. The war-devastated Afghanistan shows just $927 whereas Singapore scores $52,170.[10] On top of this, Asia contains five out of 17, biologically megadiverse countries that the Conservation International (CI) identifies (namely, China, India, Indonesia, Malaysia, and the Philippines)[11]. Having mentioned all this, Asia can be said to be one of the best cases to observe the relationships between socio-economic conditions and types of the human-induced direct threats to

[10] Source: GDP per capita, PPP (current 2005 international $). Online. World Development Indicators. World Bank. Retrieved January 29, 2013 from http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD.

[11] See http://www.conservation.org/documentaries/Pages/megadiversity.aspx and http://www.environment.gov.au/soe/2001/publications/theme-reports/biodiversity/biodiversity01-3.html.

biodiversity due to its diversity in many indicators mentioned here.

2.2 Conceptual Framework

2.2.1 Development and Demographic Pressure and Threats to Biodiversity

Previous studies heavily indicate that threats to biodiversity are primarily caused by humans. Many studies talk about impacts of human development on biodiversity (Abbitt, Scott, & Wilcove, 2000; Newbold et al., 2015; Rouget, Richardson, Cowling, Lloyd, & Lombard, 2003). Forester and Machlist (2002) modeled human factors that affect the loss of biodiversity: economic development, human population growth and government policy. The results of the attempt of modeling such factors show "the importance of relations between human social systems and biodiversity (Forester & Machlist, 2002)." A study in 2004 on threats against biodiversity and conservation in Kenya also highlights a number of human-induced threats (human population density and encroachment, loss of migration corridors and dispersal areas) and the susceptibility of protected areas in Kenya to them (Okello & Kiringe, 2004). McKee *et*

al. (2004) argues that increase in human population density is strongly correlated with mammal and bird species diversity (McKee et al., 2004).

To test whether development and demographic pressures are the major factors that are related with the threats to biodiversity, the research employs the following development and demographic indicators.

Gross National Income per capita 2014, Atlas method (current US$), World Bank

According to the World Bank (WB), Gross National Income (GNI) is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus receipts of primary income (compensation of employees and property income) from abroad.[12] The reason for which the research does not employ any other economic indicators but per-capita GNI is that World Bank has

[12] GNI per capita, Atlas method (current US$). Retrieved October 9, 2015 from data.worldbank.org/indicator/NY.GNP.PCAP.CD.

prepared a classification with thresholds to group the per-capita GNI figures of the countries into four (high, upper-middle, lower-middle and low) with the thresholds being $12,736, $4,125 and $1,050, respectively (for the grouping, see Table 4). In order to clarify whether a socio-economic indicator and the threats to biodiversity are related, chi-square tests are conducted in the research. Official/Reliable grouping is essential to obtain reliable results. The WB uses something called the Atlas method to smooth fluctuations in prices and exchange rates (GNI is calculated in national currency and then converted usually to US$ at official exchange rates for comparisons across economies, although an alternative rate is used when the official exchange rate is judged to diverge by an exceptionally large margin from the rate actually applied in international transactions). The Atlas method applies a conversion factor that averages the exchange rate for a given year and the two preceding years, adjusted for differences in rates of inflation between the countries. From 2001, they include the Euro area, Japan, the United Kingdom and the United States.[13]

[13] GNI per capita, Atlas method (current US$). Retrieved October 9, 2015 from data.worldbank.org/indicator/NY.GNP.PCAP.CD.

Table 2: GNI per capita 2014, World Bank Atlas methodology (US $)

High	US $	Upper-middle	US $	Lower-middle	US $	Low	US $
Singapore	55,150	Kazakhstan	11,670	Indonesia	3,650	Cambodia	1,010
Japan	42,000	Malaysia	10,660	Philippines	3,440	Nepal	730
Brunei Darussalam	36,710	Turkmenistan	8,020	Sri Lanka	3,400	Afghanistan	680
Korea, Rep.	27,090	China	7,380	Timor-Leste	3,120		
		Maldives	7,290	Bhutan	2,390		
		Thailand	5,410	Vietnam	1,890		
		Mongolia	4,320	India	1,610		
				Lao PDR	1,600		
				Pakistan	1,410		
				Myanmar	1,270		
				Kyrgyz Republic	1,250		
				Bangladesh	1,080		
				Tajikistan	1,060		

Annual average population change rate (%), 2010-2015, United Nations

The data used for the analysis is annual population change rate (%) 2010-2015 from the United Nations Population Division.[14]

The first question one might ask is why the research does not use an indicator to show human population density rather than population change. Indeed, when talking about demographic pressure, usually human population density is used (see, for example, (Newbold et al., 2015) and (Okello & Kiringe, 2004)). McKee *et al.* even states that current human population growth rate is not significantly related with species threats (McKee et al., 2004). However, this statement lacks information sources. What should be paid attention here when thinking of the appropriateness of the indicator is the materials of the research, i.e., the latest CBD national reports. Unlike other studies on relations between demographic pressure and threats to biodiversity, this research does not check species richness, but a more subjective measure: quantified scores of what the report writers "feel" about the demographic pressure. Species richness is perhaps the most appropriate indicator to check for correlation with human population density

[14] Population Growth Rate (XLS) from http://esa.un.org/unpd/wpp/DVD/, retrieved September 9, 2015.

because most of the times studies compare countries, or sites within a country. In such cases species richness is a good objective indicator to make comparisons, but as for the material of the research, the writes of a national report are from the country and they mostly judge how threatening the demographic pressure in the country on biodiversity is often times without scientific backup on the national reports. Here, what might influence the writers is the change of demographic pressure, rather than its absolute value (i.e., density). This is why the research refers to population change.

As for the period of the data (2010-2015), is was decided in accordance with the timing when the latest CBD reports had been made ready from CBD (most of them in 2014). The writers might have been influenced by the lively demographic change.

What is different from GNI per capita in terms of data management is, and this is one of the limits of the research, that the countries were divided into three groups (see Table 6) with thresholds determined by the researcher as no standardized grouping was available. The lower threshold is the latest (as of 2015, estimate) world average 1.18%, and the upper one is the historical highest world average recorded in 1963 of 2.19%.

Table 3: Annual population change rate (%) 2010-2015 UN

High	%	Middle	%	Low	%
Afghanistan	3.02	Pakistan	2.11	Vietnam	1.12
Timor-Leste	2.28	Singapore	1.97	Myanmar	0.82
Tajikistan	2.24	Maldives	1.79	DPRK	0.53
		Mongolia	1.74	China	0.52
		Kyrgyzstan	1.67	Sri Lanka	0.50
		Lao PDR	1.66	Korea	0.48
		Cambodia	1.62	Thailand	0.38
		Philippines	1.58	Japan	-0.12
		Kazakhstan	1.55		
		Malaysia	1.51		
		Brunei	1.47		
		Bhutan	1.46		
		Indonesia	1.28		
		Turkmenistan	1.27		

India	1.26
Bangladesh	1.20
Nepal	1.18

2.3 Methods

2.3.1 Content Analysis

Content analysis is a method for analyzing such qualitative data as the followings: books, journal or magazine articles, news papers, television show or commercials, agency reports, process notes recorded by direct service practitioners in their case records, and so on (Rubin & Babbie, 2010). It would be quite difficult to obtain the magnitude of each level-two threat of the above-mentioned IUCN-CMP scheme with no set approach for a method of measurement being agreed internationally. So, the research employed content analysis as a method that allows quantification of the magnitude of each level-two threat expressed by the number of a code in a material (CBD national report) by means of a text mining software along with the author's eyeball confirmation. It is important to make sure that the code actually represents the

particular threat. The list of codes can be found in Appendix. A group of more than one word or even sentences could have been a code to describe a level-two threat, but a set of individual words better allows the researcher to grasp a wider range in terms of codes included in the source, so each code contains individual words (like development, urban, logging, etc.).

As explained more in detail in the next section, the research has analyzed the latest CBD national reports of the 28 Asian countries, all of them being in PDF format (available on a CBD webpage[15]). The text mining free software used here called KH Coder[16], allows only to look through a text format, so the PDF reports were converted into text format. Seems simple, but it was complicated to do so because characters were not correctly transferred into the text format from PDF. So, another text mining software named QDA Miner 4 Lite (trial version) was used to more correctly convert PDF to text files. As this software let the researcher to use just a handful of functions of the full package in sale, it did not allow the coding process itself to take place (for this KH Coder was used), but did make ease the conversion of the PDF file to a text file

[15] https://www.cbd.int/reports/

[16] KH Coder is a text mining software developed and maintained by Professor Koichi Higuchi at Ritsumeikan University, Japan. It is a share ware and the researcher finds it easy to handle. Downloadable from here: khc.sourceforge.net/dl.html (click on the link on top "khcoder-200e-f.exe")

with higher accuracy.

Now, the reasons why the research has employed KH Coder to code the source are as follows. 1) It contains what the research needs for the research (coding, word counting and presentation of codes for eyeball confirmation) for free, 2) it is relatively easy to use, and 3) it has been proved and employed to a certain extent (1,095 cases of use[17]).

The list of codes was created first picking up carefully individual words that seemed to represent the concept of a threat from the IUCN-CMP Threats Classification, then upgrading the list by testing with several CBD reports. Some words have either been added to or removed from the list. To give some examples, the word "ballast" was added to 4.3 Shipping Lanes to capture the impact on aquatic ecosystems from ballast water, "GHG" (abbreviation of "greenhouse gas" often used in the reports) to 11.2 Changes in Geochemical Regimes, and "overgrazing" to 2.3 Livestock Farming and Ranching. The word "research" was removed from 6.3 Work and Other Activities since impact on biodiversity due to research activities was nowhere mentioned in the reports. "Park" was removed from 1.3 Tourism and Recreation Areas as the term is mainly used

[17] Source: khc.sourceforge.net/en/ (retrieved Dec 18, 2015. See the second dot "Research Using KH Coder.")

as a part of national/nature “parks” in the reports. The term “range” was removed from 6.2 War, Civil Unrest and Military Exercises as mostly the word actually means “scope,” and not in the military sense.

After counting the number of the codes of a threat for a country, each number was divided by the total number of sentences included in the country’s report in order to convert the number of codes into percentage. In this manner, after all the coding had been over, we could compare the percentage on the same basis: the percentage figures were converted into 1 to 5 interval scores for statistical analyses.

Latest CBD National Reports[18]

As materials for the research, the latest CBD national reports of the 28 Asian countries were chosen. Here are the reasons. The first one is the language, namely, English. Sources for the research should be accessible, but reaching each country’s report from the government one by one is not always the best way, particularly for those Asian countries: Most of the cases the reports are written in local languages and often times

[18] Available on https://www.cbd.int/reports.

English versions are not available as those reports are intended mainly for internal use. Secondly, the formats are not the same either, making the reports to differ in content as well as in quantity. The good point of the CBD report is that CBD has prepared a format to follow and thus content and quantity do not vary too much from a country to another. Also, they are all written in English for the international reference purpose.

The CBD's definition of "Asia" includes 29 countries, as mentioned earlier. The missing one is Uzbekistan. However, in its case uniquely, the report is available only in Russian, so the country was set aside from the country list for the research.

IUCN-CMP Threats Classification Scheme

The threats to biodiversity used in the research are from the latest IUCN-CMP threats classification scheme. The scheme includes 11 major threats ("level-one" threats) and 43 sub-threats ("level-two" threats). Even though the scheme presents even lower level or "level-three" threats, this research does not employ them since they are still under discussion amongst researchers worldwide (well, level-one and level-two threats have not yet been finally fixed and are under continuous development by academia, but they

seem to have been more qualified to be used for the research as heavy reviews have been done over more than seven years of use[19]). The 11 major or "level-one" threats are 1) residential and commercial development, 2) agriculture and aquaculture, 3) energy production and mining, 4) transportation and service corridors, 5) biological resource use, 6) human intrusions and disturbance, 7) natural system modifications, 8) invasive and other problematic species, genes and diseases, 9) pollution, 10) geological events, and 11) climate change and severe weather.[20] For the entire list of the level-one and level-two threats with definitions, please see Appendix.

To add a short history of the threats classification scheme, it was first presented to the public early 2000's. Salafsky *et al.* (2002) proposed a conceptual framework for a standard lexicon to classify the threats to biodiversity (Nick Salafsky et al., 2002). This idea of a standard lexicon for threats developed and in 2006, IUCN–CMP (Conservation Measures Partnership) threats classification scheme Version 1.0 was

[19] Instruction for Reviewers of Version 2.0 Beta of the IUCN-CMP Classifications of Conservation Actions and Threats. Retrieved on October 9, 2015. Available on cmp-openstandards.org/using-os/tools/classification-beta-v-2-0.
[20] Threats Taxonomy. Retrieved on October 9, 2015 from cmp-openstandards.org/using-os/tools/threats-taxonomy/.

introduced (IUCN & CMP, 2006). It has been widely accepted by the conservation community since then. To raise an example, PAME studies (Leverington et al., 2010; Nolte et al., 2010) employed the scheme heavily with modifications so that it could fit into the PA context.

2.3.2 Factor Analysis

Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors.[21] This is a powerful and probably the best suited statistical tool to reveal the relationship between threats to biodiversity and socio-economic items. As mentioned earlier, it has been difficult to get the magnitude of a threat in a country for all the level-two items of the IUCN CMP scheme. This is why we conducted the content analysis to get the magnitudes as form of one to five interval data. With those, probably one of the most efficient ways to obtain the "factors" (or latent variables) that explain these threats is the factor analysis. It statistically helps guess these variables. In

[21] Factor analysis. Retrieved on September 9, 2015 from *Wikipedia* https://en.wikipedia.org/wiki/Factor_analysis.

relation to one of the hypotheses, the question is whether the development and demographic factors are the latent variables behind the observed correlated variables or the level-two threats. As for the statistics software, the free and widely accepted “R” was used.

2.3.3 Research Hypotheses

The researcher supposes and holds as the hypotheses of the study that socio-economic factors such as development and demographic pressures are the major factors to influence the human induced threats to biodiversity. More precisely, relations are to be expected roughly between (see Table 3 for details):

- GNI per capita and IUCN-CMP 1/2/3/4/5/7/9
    - Petty-Clark’s Law: 1/2/3/4/5/7

      It is an economic theory that the labor is reallocated from agricultural to non-agricultural activities such as manufacturing, according to economic development (Murata, 2008). Petty-Clark’s Law is also called the

three-sector growth hypothesis where economies are divided into three sectors: agriculture and extraction of raw materials (primary sector), manufacturing and construction (secondary sector), and services (tertiary sector). The hypothesis was first presented to the modern society by Collin Clark in 1940 (Clark, 1940). The theory or law carries the name of Petty because Clark referred to his work of 17th century that discussed similar ideas.

2, 3, and 5 of the IUCN-CMP level-one threats correspond to the primary sector while 1, 4, and 7 to the secondary sector. Thus, although there are some exceptions at the level two that seem to be irrelevant with those economic sectors (3.3 Renewable energy, 4.4 Flight paths, 7.1 Fire and fire suppression, and 7.4 Removing/Reducing human maintenance), basically GNI per capita is expected to be related with these threats from the primary sector (presented in lighter red on Table 3) and those from the secondary sector (darker red).

- Environmental Kuznets Curve: 9

According to a book about sustainable development (Rao, 2000), Environmental Kuznets Curve (EKC) is an environmental hypothesis or counterpart to the original Kuznets curve that Kuznets published in 1955. The curve is an inverted U relationship between a measure of inequality in the distribution of income and economic growth (Kuznets, 1955). The concept of EKC was first presented in a 1996 study (Parikh, 1996) about the relationship between per capita GNP and per capita elasticity of CO2 emissions. EKC is an environmental hypothesis based on the same logic with the Kuznets curve: rises in per capita incomes and the changes in per capita emissions of pollutants should show the U relationship. In other words, the positive link between economic growth and the quality of the environment changes its direction after a peak level of a pollutant.

- Population growth pressure and IUCN-CMP 1/2/5/7
    - As little research on which threat to be impacted by demographic pressure is available, threats due to ecosystem services related to food, shelter and energy were selected as expected threat items relating with demographic

pressure. Therefore, at the level two, the following threats have are expected to be related with population growth pressure: food for 2.1, 2.3, 5.1, 5.2 and 5.4 (in green), shelter for 1.1 and 7.3 (in blue), and energy for 5.3 (in orange).

Table 4: Hypotheses: Expected relations between socio-economic factors and IUCN-CMP threats classification

IUCN-CMP Classification Scheme		GNI per capita	Population growth pressure
1. Residential & Commercial Development	*1.1 Housing & urban areas		
	*1.2 Commercial & industrial areas		
	*1.3 Tourism & recreation areas		
2. Agriculture & Aquaculture	*2.1 Annual & perennial non-timber crops		
	*2.2 Wood & pulp plantations		
	*2.3 Livestock farming & ranching		
	*2.4 Marine & freshwater aquaculture		
3. Energy Production & Mining	*3.1 Oil & gas drilling		
	*3.2 Mining & quarrying		
	*3.3 Renewable energy		
4. Transportation & Service Corridors	*4.1 Roads & railroads		
	*4.2 Utility & service lines		
	*4.3 Shipping lanes		
	*4.4 Flight paths		
5. Biological Resource Use	*5.1 Hunting & collecting terrestrial animals		
	*5.2 Gathering terrestrial plants		
	*5.3 Logging & wood harvesting		
	*5.4 Fishing & harvesting aquatic resources		
6. Human Intrusions & Disturbance	*6.1 Recreational activities		
	*6.2 War, civil unrest & military exercises		
	*6.3 Work & other activities		
7. Natural System Modifications	*7.1 Fire & fire suppression		
	*7.2 Dams & water management/use		
	*7.3 Other ecosystem modifications		
	*7.4 Removing / reducing human maintenance		
8. Invasive & Problematic Species, Pathogens & Genes	*8.1 Invasive non-native/alien species plants & animals		
	*8.2 Problematic native plants & animals		
	*8.3 Introduced genetic material		
	*8.4 Pathogens & microbes		
9. Pollution	*9.1 Household sewage & urban waste water		
	*9.2 Industrial & military effluents		
	*9.3 Agricultural & forestry effluents		
	*9.4 Garbage & solid waste		
	*9.5 Air-borne pollutants		
	*9.6 Excess energy		
10. Geological Events	*10.1 Volcanoes		
	*10.2 Earthquakes/tsunamis		
	*10.3 Avalanches/landslides		
11. Climate Change	*11.1 Ecosystem encroachment		
	*11.2 Changes in geochemical regimes		
	*11.3 Changes in temperature regimes		
	*11.4 Changes in precipitation & broad-scale hydrological regimes		
	*11.5 Severe/extreme weather events		

Primary sector of industry
Secondary sector of industry
Pollution
Food
Shelter
Energy

2. Results

The per-capita GNI, as the representative of the development pressure, is related to urban development (1.1), water and air pollution (9.2 and 9.5) and atmospheric temperature increase (11.3) in Asia. The relation with 1.1 is straight forward. 9.2 and 9.5 are as expected from the EKC. Other pollution-related level-two threats turned out to be unrelated with the per-capita GNI. The rationale behind the relationship between 11.3 and the per-capita GNI is unclear.

As for the average population change % from 2010 to 2015 as an indicator of the demographic pressure, it is related to 5.1 Hunting and 11.3 Temperature Regimes. 5.1 is kind of understandable given the number of Asian countries where hunting is highly present, but it is hard to estimate the connection between 11.3 and population change.

Five factors have been estimated to be the major “root causes” in the 28 Asian countries that are related with the level-two threats to biodiversity. Those five that have been named by the researcher are: natural resource exploitation, tourism, oil production, urbanization and secondary sector of industry.

This result indeed matches, in large direction, that of 2010 PAME study. P.43 of the

report shows that among the 227 studies about PAME worldwide, the most frequently recorded level-two threat is 5.1 Hunting, followed by 5.3 Logging, 2.3 Livestock Farming and 6.1 Recreational Activities (Leverington et al., 2010). In other words, natural resource use and recreational activities (including tourism) are definitely the major threats to biodiversity. The result of our research includes even 3.1 Oil/Gas Drilling for the natural resource use, but this may be because the research deals with biodiversity whereas the PAME study focuses on PAs (perhaps oil/gas drilling was not as highly present in PAs as elsewhere of a country).

3.1 Process of Analysis

In order to make a rough estimation of how many factors there would be to explain the 43 level-two threats, the correlations of any given pair between the 43 items were checked. Among those, the pairs with the correlation coefficient +0.5 and above were picked up for examination. The highlighted pairs below are the ones chosen to proceed to the factor analysis.

Table 5: Pairs of level-two Threat Items Correlated at Coefficient +0.5 and above

+0.9~1.0	+0.8~	+0.7~	+0.6~		+0.5~		
8.2&10.1	8.3&10.2	1.3&6.1	3.1&9.5	6.3&4.1	1.1&1.2	2.4&9.1	6.3&10.3
8.2&10.2	8.3&10.1	2.3&7.4	2.3&9.5	2.2&3.1	2.3&3.1	3.1&11.2	8.4&9.2
10.1&10.2	8.3&8.2	1.1&8.2	11.3&8.1	1.3&4.1	2.1&3.3	4.2&11.2	9.1&9.2
		1.1&10.1	11.2&9.2	11.3&1.1	2.2&4.3	5.1&5.3	9.2&9.5
		1.1&10.2	11.1&9.2	11.1&2.3	2.2&5.1	5.1&6.3	8.1&11.2
		3.1&5.2	9.2&8.1	1.3&1.2	2.3&5.2	5.1&9.2	8.4&11.2
		4.2&11.5	5.4&9.1	9.5&11.2	2.2&8.1	5.2&9.2	8.2&11.3
		6.1&11.1	1.1&8.3		2.2&9.1	5.3&9.2	8.1&11.4
		2.2&9.2	6.1&6.3		1.3&9.2	5.4&9.4	9.2&11.4
		3.1&9.2	1.3&6.3		1.3&9.4	6.1&9.4	10.1&11.3
		3.1&11.1	11.1&5.1		1.3&11.1	6.1&9.5	11.3&1.2
		9.5&11.1	5.3&5.2		1.2&11.3	5.1&9.6	11.2&11.3
			4.1&6.1		3.1&4.3	6.1&9.6	11.3&11.4
			5.4&2.2		3.1&5.3	5.3&11.4	

		5.3&2.2	3.2&6.1	6.3&9.1
		5.2&2.2	4.1&7.2	6.3&9.4

After a number of trials, the following 14 items were chosen to proceed to the next step.

1.1 Housing & urban areas

1.2 Commercial & industrial areas

1.3 Tourism & recreation areas

3.1 Oil & gas drilling

4.1 Roads & railroads

4.2 Utility & service lines (mainly oil pipelines)

5.1 Hunting & collecting terrestrial animals

5.3 Logging & wood harvesting

6.1 Recreational activities

9.1 Household sewage & urban waste water

9.2 Industrial & military effluents

9.5 Air-borne pollutants

11.2 Changes in geochemical regimes (mainly CO2 increase and ocean/soil acidification due to climate change)

11.3 Changes in temperature regimes

Six items were dropped off.[22] Factor analysis on the 14 items shows that five factors explain more than 75% of the common background of the 14 at p-value = 0.08 (>0.05) (Illustration 1: Factor analysis result 0). Each factor was examined through further factor analysis to make sure that the grouping is statistically significant. The results are presented in Appendix (Factor analysis 1 through 5). All the cases show statistical significance with p-values over 0.05 and the majority gives cumulative variance that equals to 0.5 or above, except for Factor 4 (0.457) which is still close to 0.5. Each case includes four items since it did not statistically make sense to conduct factor analyses with three items or less. The four items were chosen based on the degree of correlation coefficient from the highest (see Illustration 1: Factor analysis result 0).

We will name each group as follows.

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[22] 2.3 Livestock farming & ranching

2.4 Marine & freshwater aquaculture

6.3 Work & other activities (mainly illegal activities)

8.1 Invasive non-native/alien species plants & animals

8.4 Pathogens & microbes

11.1 Ecosystem encroachment (mainly desertification due to climate change)

Factor 1: 5.3, 3.1, 9.2, 5.1 --> Natural resource exploitation

Factor 2: 6.1, 1.3, 4.1, 5.1 --> Tourism

Factor 3: 11.2, 4.2, 9.5, 3.1 --> Oil production

Factor 4: 11.3, 1.1, 11.2, 9.1 --> Urbanization

Factor 5: 1.2, 1.3, 4.1, 1.1 --> Secondary sector of industry

As the aim of the research is to see whether socio-economic factors such as economic development and demographic pressures have relationship with the threats to biodiversity, a thorough check was conducted with those five factors if the socio-economic factors, namely the per-capita GNI and the population change rate, are actually related with them. First, those five factors were analyzed through further factor analysis to see if any common factors would exist behind. The result is that there are two factors explaining these five groups at 46% with statistical significance being secured (Illustration 7: Factor analysis result 6). However, what makes further analysis difficult is that the first factor explains the “Tourism” group most and positively, while other groups are negatively correlated with the “root cause”. If this was some sort of

economic development indicator like GNI per capita increase, it could explain the positive correlation with Tourism as time and money for leisure would expand as GNI increases. However, GNI increase would not necessarily be negatively correlated with the other four groups, namely natural resource exploitation, oil production, urbanization and secondary sector of industry. Rather, the relations should be positive. To confirm, chi-square tests were done to see if per-capita GNI increase was related with each one of the 14 threat items. In case chi-square test turned an error, Fisher"s exact test was done alternatively.

The result is that change in per-capita GNI is related with 1.1, 9.2, 9.5 and 11.3. In other words, it is related to urban development (1.1), pollution (9.2 and 9.5) and atmospheric temperature increase (11.3). It is NOT related to the other numerous threats. The statistical result is included in Appendix (Illustration 8: Chi-square tests GNI per capita).

The same tests were done for the population change rate. The result this time is that it

is related with 5.1 (hunting) and 11.3 (water/air temperature increases due to climate change) (Illustration 9: Chi-square tests population change (%) 2010-2015).

In sum, the hypothesis that the development and demographic pressures are the major factors that are related with the threats to biodiversity was not proved, at least in Asia. However, we have found that the five issues-natural resource exploitation, tourism, oil production, urbanization and secondary sector of industry-seem to be the major "root causes" of the threats to biodiversity.

3. Discussion

Petty-Clark's Law was proved only for 1.1 Housing and Urban Areas. Development pressure and pollution were related as predicted by theories like EKC, particularly for 9.2 Industrial and Military Effluents and 9.5 Air-Borne Pollutants.

A possible reason why Petty-Clark's Law did not apply to the other threats of the hypotheses that were expected to be related to primary/secondary sector of industry

might be that Asia's development had varied at a level beyond the Law. For example, Asia includes middle to high per-capita GNI countries largely based on fossil fuels and minerals (petroleum, natural gas, metals, etc.) such as Brunei, Kazakhstan, Malaysia, Turkmenistan, Kyrgyzstan and Tajikistan.[23] Citizens of these countries enjoy relatively large amounts of per-capita GNI thanks to the natural resources. In these countries, the industrial shift from the primary sector to the second is not necessarily always applicable. The secondary sector of industry may not have to develop as that of the industrialized countries such as Singapore, Japan or Korea since these natural resource based countries earn enough from extractions of petroleum, natural gas, metals, etc. Also, such extractions may not require as much workforce as the second sector of industry, leading the workforce stick to the other sections of the primary sector of industry such as agriculture, pasturage, forestry or fishing. This perhaps put 9.3 Agricultural and Forestry Effluent out of the relation with per-capita GNI. As a result of this stay of the primary-sector workforce (thus little urbanization or lifestyle change),

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[23] The major resources of the countries (retrieved on October 11, 2015 from web pages of Japanese Ministry of Foreign Affairs)

Brunei	: Petroleum and natural gas
Kazakhstan	: Petroleum, natural gas, uranium, chromium, zinc
Malaysia	: Tin, petroleum and natural gas
Turkmenistan	: Petroleum and natural gas
Kyrgyzstan	: Gold
Tajikistan	: Aluminum

relationship with the GNI per capita was not observed for 9.1 Household Sewage and Urban Waste Water. With regard to 9.4 Garbage and Solid Waste and 9.6 Excess Energy, relationship with the GNI per capita was not observed perhaps because the tertiary sector may produce less of these than the secondary sector (remember that high and middle per-capita GNI countries may or may not include developed tertiary sector depending on their major economic activities).

It is comprehensible that population growth pressure is related with hunting magnitude since it is generally higher in developing countries where hunting is often source of protein.[24] The population growth pressure is not related with all the rest but 11.3 Changes in Temperature Regimes. The hypothesis that PGP is related with the threats to biodiversity stemmed from food, shelter and energy was not proved.

As for the development pressure and 11.3, among the high and upper-middle per-capita

[24] For reference, according to the respective CBD national reports, Kazakhstan, Kyrgyzstan and Tajikistan regard it as games based on their traditional view and as a tourism attraction. In Thailand, for its popular hunting novels in the past, hunting has been one of the major threats to biodiversity. These four are middle per-capita GNI countries.

GNI countries, Japan, Korea, Thailand and Turkmenistan reported the highest magnitudes of 11.3. Per-capita GNI data is as of 2014 while 11.3 is something that has occurred over a much longer period, so it seems to be reasonable to state that it is a mere coincidence that the development pressure and 11.3 are related. The same perhaps applies to the relationship between the population growth pressure and 11.3. Among the high and middle countries in terms of population growth pressure, Afghanistan and Tajikistan recorded the highest. As we do not see an explicit link between the population growth pressure and 11.3, again, the relation is perhaps a mere coincidence. Further research anyway is needed to clarify these links between the socio-economic factors and 11.3.

4.1 Limits of the Research

The “root causes” of the five indirect threats to biodiversity (at least in Asia) remain unknown. They are at least not development and demographic pressures. Further research is needed to see if the level-two threats related to the primary/secondary sector in industrialized countries of other regions are related with the per-capita GNI. In this

particular research, the fact that the geographical scope is Asia, where a good number of countries economically rely on fossil fuel and mineral resources, perhaps limited the relationship of the per-capita GNI only with 1.1 Housing and Urban Areas, unlike expected based on Petty-Clark's Law. Also, further research is needed to clarify the relationship between 11.3 Changes in Temperature Regimes and the per-capita GNI / population growth pressure.

4. Conclusion

The major threats to biodiversity in Asia seem to stem from 1) natural resource exploitation, 2) tourism, 3) oil production, 4) urbanization and 5) activities of secondary sector of industry. The development and demographic pressures do not seem to be the "root causes" of these threats. Economic development that boosts them will never stop, so managing them will be essential in order to reduce their impacts on biodiversity.

To a certain extent, it is fair to say that humans have right to use resources on Earth since they are also part of biodiversity. The problem is over exploitation. This is why it

would be essential to seek for the best balance between development / human well-being and nature conservation as the majority of the CBD national reports suggests, even though it might be an endless endeavor to find it. And up to here is something that past studies have already discussed quite intensely, and that even today remains to be the issue to address. Why would it be difficult? It is because of lack of structural and institutional capacity and skills to set rules, implement and evaluate them as mentioned in the majority of the CBD national reports. The situation of Asia in this regard does not look promising. Here are some of the considerations that the Asian countries have, with regard to the lack of fund and capacity for conservation of biodiversity.

> "[T]here is a lack of integration of environmental considerations in planning, resulting in the absence for a truly integrated land and water resources management (Bangladesh, 2010)."

> "[I]n fulfilling the principles of CBD, the main challenge is the lack of financial resources and inadequate human capacity to implement. Although there are strong policies that integrate biodiversity issues in all the sectors, lack of proper coordination during the implementation causes lots of insolvencies (Bhutan, 2010)."

“The lack of protected areas management plans with formal conservation core zones has allowed for Economic Land Concessions to be placed within protected areas, sometimes with significant biodiversity impacts: …a lack of planning and law enforcement in natural resource management and conservation (Cambodia, 2014b).”

“Capacities for surveying and monitoring biodiversity, establishment and management of nature reserves and restoration of biodiversity are still very weak and funds are seriously inadequate. Due to inadequate law enforcement conditions and lack of adequate infrastructure or equipment in some sites, relevant laws cannot be enforced (China, 2014).”

A review in 2012 of the implemented national action plan of Indonesia shows “at least eight challenges that affect the implementation of biodiversity management through policy-making and field activities, namely: (i) lack of understanding of the function of biodiversity in the area; (ii) Biodiversity issues have not become major issues; (iii) lack of political support; (iv) lack of adequate human resources with knowledge of issues on Biological Diversity; (v) lack of synergy of the Biodiversity programs; (vi) lack of dissemination of the Biodiversity management policy; (vii) the absence of monitoring institutions and evaluation in the area; (viii) lack of stakeholders involvement in the area (Indonesia, 2014).”

“[T]he number of hunters who have been playing central roles in the capture of wildlife is rapidly decreasing or they are aging, and a lack of wildlife control personnel is becoming a major problem (Japan, 2014).”

“In addition to the continued ineffective legislative and regulatory framework, serious problems associated with execution of the legislation and the lack of control on the ground for various reasons; including corruption and lack of skills, still remain (Kazakhstan, 2014).”

“Fully achieving the 2010 Target remains elusive since there are barriers or obstacles that hinder the implementation of activities. Foremost is the lack of sufficient funds for a sustainable implementation of activities. Second is the availability of qualified personnel which is severely lacking in many of the implementing agencies (Laos, 2010).”

“The Policy [(National Policy on Biological Diversity)] does not delegate implementation duties to relevant agencies resulting in lack of ownership of some of the Policy’s components (Malaysia, 2014).”

Key challenges and obstacles in implementing NBSAP are lack of capacity, lack of resources or funding, issues with stakeholder participation, difficulties of coordination between multiple sectors and agencies, competing interests between sectors, unclear and overlapping mandates, lack of

regularity or follow up, and weakness or lack of Laws and regulations (Maldives, 2010).

"The first review in 2000 indicated that the NBAP [(National Biodiversity Action Plan)] was only partially filling its objectives due to there being issues with project implementation; a lack of coordination, monitoring and management meant there was a lack of detailed awareness of overall implementation of projects. Although there were holes in overall coordination a significant number of actions were being implemented. This review highlighted the lesson that in order to improve the efficiency of output to ensure greater NBAP targets are met, improved implementation of the plans should be exercised (Mongolia, 2014)."

"In Myanmar, one of the major factors for forest degradation and habitat and biodiversity loss is a lack of land-use policies and planning. Moreover, unplanned expansion of commercial plantations, such as oil palm and cassava, is leading to large-scale conversion of forest areas (Myanmar, 2014)."

Some of the major underlying factors to the threats to biodiversity in Nepal are "weak enforcement of law and governance; ignorance to biodiversity values in government and corporate accounting systems; inadequate awareness and motivation to conserve biodiversity; …and lack of an integrated approaches to development planning at the national and district levels (Nepal, 2014)."

“A major reason for lack of proper implementation of the BAP [(Biodiversity Action Plan)] is that the targets were too ambitious without taking into consideration the financial constraints and lack of human resource and institutional capacity. Furthermore, there was a lack of political will and insufficient financial allocation of the government resources (Pakistan, 2014).”

“Indirect drivers [(of biodiversity and ecosystem service loss)] have also been identified, among them institutional factors, such as low economic rent, overlapping government mandates, inconsistent policies, weak law enforcement and lack of political will (Philippines, 2014).”

“Lack of strategic use of land during development resulting in loss of critical forests and important wildlife habitats, and wetlands (Sri-Lanka, 2014)”

Some of the main issues about degraded pasturelands in Tajikistan are: “lack of the managing system for rational use and preservation of pasture resources; lack of monitoring results on cultural-technical state of pastures in the country (have not been conducted for about 25 years); and lack of activities directed at simplificated improvement and amelioration of pastures (the sources allocated from the budget and directed for improvement of pastures are insignificant) (Tajikistan, 2014).”

“Lack of trained personnel to manage the protected areas is severe and the financial resources that

accompany management is also lacking (Timor-Leste, 2010)."

"Lack of specialists of nature protection and reserve business does not promote execution of year-round monitoring, scientific researches and efficient biodiversity protection (Turkmenistan, 2009)."

"The system of state management agencies responsible for biodiversity remains fragmented and weak - laws and regulations to protect biodiversity are still unsystematic and lacking in policy conformity; …planning for national, regional and provincial biodiversity conservation has not been implemented in a systematic manner; and investment in biodiversity conservation and development remains highly limited (Vietnam, 2014)."

The conservation budgetary and capacity conditions surrounding the Asian countries do not seem to be optimistic. However, at least from this research about 28 Asian countries, we have learned that one indication we should have slightly more attention to and efforts for is how to make possible the conservation rule setting, its solid implementation and evaluation for improvement. A pre-assessment of the construction of a gas pipeline in Mexico about its potential routes is a good example of its kind. The

study was submitted to the Mexican Environmental Ministry and the pipeline project was approved upon the request of the research (Zuniga-Gutierrez, Arroyo-Cabrales, Lechuga, & Ortega-Rubio, 2002). Development perhaps damages the nature, but humans can alleviate the damage through capacity development: this kind of research before a construction project, for example. What was initiated by humans will have to be, and can only be, mitigated, if not stopped, by the hands of the humans. There is still a long way to go, but it could be achieved if conservation budget and capacity ate to be secured. At least those countries expecting further economic growth can be prepared to mitigate threats to biodiversity from housing and urban area development and water and air pollution, and the countries with growing population can focus on mitigation of hunting.

Appendix

IUCN-CMP Threats Classification Scheme[25]

1 Residential & Commercial Development

Threats from human settlements or other non-agricultural land uses with a substantial footprint

1.1 Housing & Urban Areas

Human cities, towns, and settlements including non-housing development typically integrated with housing

1.2 Commercial & Industrial Areas

Factories and other commercial centers

1.3 Tourism & Recreation Areas

Tourism and recreation sites with a substantial footprint

2 Agriculture & Aquaculture

Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture and aquaculture

2.1 Annual & Perennial Non-Timber Crops

Crops planted for food, fodder, fiber, fuel, or other uses

2.2 Wood & Pulp Plantations

Stands of trees planted for timber or fiber outside of natural forests, often with non-native species

2.3 Livestock Farming & Ranching

Domestic terrestrial animals raised in one location on farmed or non-local resources (farming); also domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching)

[25] Source: cmp-openstandards.org/using-os/tools/threats-taxonomy/

2.4 Marine & Freshwater Aquaculture

Aquatic animals raised in one location on farmed or non-local resources; also hatchery fish allowed to roam in the wild

3 Energy Production & Mining

Threats from production of non-biological resources

3.1 Oil & Gas Drilling

Exploring for, developing, and producing petroleum and other liquid hydrocarbons

3.2 Mining & Quarrying

Exploring for, developing, and producing minerals and rocks

3.3 Renewable Energy

Exploring, developing, and producing renewable energy

4 Transportation & Service Corridors

Threats from long narrow transport corridors and the vehicles that use them including associated wildlife mortality

4.1 Roads & Railroads

Surface transport on roadways and dedicated tracks

4.2 Utility & Service Lines

Transport of energy & resources

4.3 Shipping Lanes

Transport on and in freshwater and ocean waterways

4.4 Flight Paths

Air and space transport

5 Biological Resource Use

Threats from consumptive use of 。-wild。7 biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species

5.1 Hunting & Collecting Terrestrial Animals

Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch

5.2 Gathering Terrestrial Plants

Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons

5.3 Logging & Wood Harvesting

Harvesting trees and other woody vegetation for timber, fiber, or fuel

5.4 Fishing & Harvesting Aquatic Resources

Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch

6 Human Intrusions & Disturbance

Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources

6.1 Recreational Activities

People spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons

6.2 War, Civil Unrest & Military Exercises

Actions by formal or paramilitary forces without a permanent footprint

6.3 Work & Other Activities

People spending time in or traveling in natural environments for reasons other than recreation, military activities, or research

7 Natural System Modifications

Threats from actions that convert or degrade habitat in service of managing natural or semi-natural systems, often to improve human welfare

7.1 Fire & Fire Suppression

Suppression or increase in fire frequency and/or intensity outside of its natural range of variation

7.2 Dams & Water Management/Use

Changing water flow patterns from their natural range of variation either deliberately or as a result of other activities

7.3 Other Ecosystem Modifications

Other actions that convert or degrade habitat in service of managing natural systems to improve human welfare

8 Invasive & Other Problematic Species & Genes

Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance

8.1 Invasive Non-Native/Alien Species

Harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities

8.2 Problematic Native Species

Harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become ?out-of-balance? or ?released? directly or indirectly due to human activities

8.3 Introduced Genetic Material

Human altered or transported organisms or genes

9 Pollution

Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources

9.1 Household Sewage & Urban Waste Water

Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments

9.2 Industrial & Military Effluents

Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments

9.3 Agricultural & Forestry Effluents

Water-borne pollutants from agricultural, silvicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied

9.4 Garbage & Solid Waste

Rubbish and other solid materials including those that entangle wildlife

9.5 Air-Borne Pollutants

Atmospheric pollutants from point and nonpoint sources

9.6 Excess Energy

Inputs of heat, sound, or light that disturb wildlife or ecosystems

10 Geological Events

Threats from catastrophic geological events

10.1 Volcanoes

Volcanic events

10.2 Earthquakes/Tsunamis

Earthquakes and associated events

10.3 Avalanches/Landslides

Avalanches or landslides

11 Climate Change & Severe Weather

Threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat

11.1 Habitat Shifting & Alteration

Major changes in habitat composition and location

11.2 Droughts

Periods in which rainfall falls below the normal range of variation

11.3 Temperature Extremes

Periods in which temperatures exceed or go below the normal range of variation

11.4 Storms & Flooding

Extreme precipitation and/or wind events

List of Codes

*1.1 Housing & urban areas

housing | urban | suburb | village | home | office | school | hospital | house | city | town | downtown | residence | development | urbanization | urbanisation

*1.2 Commercial & industrial areas

factory | shop | yard | airport | port | mall | cinema | theater | industry

*1.3 Tourism & recreation areas

ski | golf | resort | cricket | camp | tourism | recreation | vacation

*2.1 Annual & perennial non-timber crops

crop | farm | swidden | plantation | orchard | vineyard | agroforestry | slash-and-burn | fodder

*2.2 Wood & pulp plantations

pulp | teak | eucalyptus | silviculture | christmas | plantation

*2.3 Livestock farming & ranching

livestock | ranch | cattle | dairy | chicken | goat | camel | yak | herd | roam | overgrazing

*2.4 Marine & freshwater aquaculture

aquaculture | shrimp | pond | hatchery | salmon | shellfish | algal | seaweed | aquatic | mariculture | farming

*3.1 Oil & gas drilling

oil | gas | drill | petroleum | hydrocarbon

*3.2 Mining & quarrying

mining | quarrying | coal | gold | panning | nodule | guano | mineral

*3.3 Renewable energy

geothermal | solar | wind

*4.1 Roads & railroads

road | railroad | highway | bridges | causeway | train | vehicle | car | truck | railway

*4.2 Utility & service lines

utility | wire | aqueduct | pipeline | electrocution

*4.3 Shipping lanes

dredge | canal | lane | whale | wake | cargo | shipping | waterway | ballast

*4.4 Flight paths

flight | jet | plane

*5.1 Hunting & collecting terrestrial animals

bushmeat | hunt | hunting | kill | killing | fur | trap | collecting | nest | predator | persecute | otter | beaver | amphibian | bear | penguin | waterfowl | bird

*5.2 Gathering terrestrial plants

forage | stall | gathering | mushroom | orchid | rattan | fungi

*5.3 Logging & wood harvesting

logging | wood | cutting | hardwood | ironwood | pulp | charcoal | timber

*5.4 Fishing & harvesting aquatic resources

fishing | aquatic | trawl | blast | spear | shellfish | whale | seal | turtle | coral | seaweed | bycatch

*6.1 Recreational activities

recreation | recreational | vehicle | motorboat | ski | snowmobile | plane | boat | bike | hike | birdwatcher | camp | caving | climbing

*6.2 War, civil unrest & military exercises

war | unrest | military | arm | conflict | mine | tank | defoliation | munition | bullet | force

*6.3 Work & other activities

smuggle | illegal | immigrant | vandalism | poach

*7.1 Fire & fire suppression

fire | suppression | arson | campfire | burn

*7.2 Dams & water management/use

dam | sediment | wetland | filling | levee | dike | diversion | groundwater | pump | channelize | lake | flow | hydrology | hydropower

*7.3 Other ecosystem modifications

reclamation | riprap | shoreline | mow | thinning | construction | snag

*7.4 Removing / reducing human maintenance

meadow | lack | funding | constraint | restriction | inadequate | insufficient

*8.1 Invasive non-native/alien species plants & animals

invasive | alien | feral | pet | Miconia | exotic | invade | IAS

*8.2 Problematic native plants & animals

overabundant | native | deer | algae | plague | rodent

*8.3 Introduced genetic material

non-local | modified | modification | transport | introduce

*8.4 Pathogens & microbes

pathogen | microbe | disease | illness | blight | chytrid | fungus | bacteria | virus | prion | pest

*9.1 Household sewage & urban waste water

sewage | discharge | waste | leak | septic | untreated | outhouses | sediment | lawn | nutrient | toxic | chemical | caffeine | pharmaceutical | polluant

*9.2 Industrial & military effluents

effluent | toxic | chemical | tailing | arsenic | leak | PCB | sediment | nutrient | spill | oil

*9.3 Agricultural & forestry effluents

effluent | nutrient | fertilizer | herbicide | manure | pesticide

*9.4 Garbage & solid waste

garbage | waste | litter | flotsam | jetsam | debris | rubbish

*9.5 Air-borne pollutants

acid | smog | emission | nitrogen | radioactive | smoke | air | atmosphere

*9.6 Excess energy

noise | sonar | heat | radiation

*10.1 Volcanoes

volcano | eruption | gas

*10.2 Earthquakes/tsunamis

earthquake | tsunami

*10.3 Avalanches/landslides

avalanche | landslide | mudslide

*11.1 Ecosystem encroachment

encroach | inundation | drown | desertification

*11.2 Changes in geochemical regimes

acidification | CO2 | geochemical | greenhouse | GHG

*11.3 Changes in temperature regimes

heat | cold | temperature | melt | glacier | ice

*11.4 Changes in precipitation & broad-scale hydrological regimes

precipitation | rain | drought | snow | flood | evapotranspiration | hydrological

*11.5 Severe/extreme weather events

storm | hurricane | cyclone | tornado | typhoon | blizzard | erosion

Statistical Data

Illustration 1: Factor analysis result 0

Uniquenesses:

X1.1	X1.2	X1.3	X3.1	X4.1	X4.2	X5.1	X5.3	X6.1	X9.1	X9.2	X9.5	X11.2	X11.3
0.406	0.005	0.091	0.166	0.364	0.468	0.276	0.400	0.005	0.715	0.137	0.427	0.005	0.005

Loadings:

	Factor1	Factor2	Factor3	Factor4	Factor5
X1.1	0.608	-0.295	-0.335		0.158
X1.2	0.726	-0.345		0.562	-0.179
X1.3	0.685	0.386		0.532	
X3.1	0.383	0.342	0.670	-0.221	-0.268
X4.1	0.529	0.413		0.431	
X4.2	0.214	0.500		-0.205	-0.437
X5.1	0.346	0.270	0.568	0.168	0.424
X5.3	0.167		0.733	-0.128	0.125
X6.1	0.411	0.861		0.234	0.170
X9.1	0.311	0.195	0.325		0.209
X9.2	0.643	0.280	0.595	-0.130	
X9.5	0.490	0.521	0.137	-0.191	
X11.2	0.819	0.219		-0.433	-0.297
X11.3	0.819	-0.384		-0.204	0.367

	Factor1	Factor2	Factor3	Factor4	Factor5
SS loadings	4.248	2.294	1.904	1.258	0.825
Proportion Var	0.303	0.164	0.136	0.090	0.059
Cumulative Var	0.303	0.467	0.603	0.693	0.752

Test of the hypothesis that 5 factors are sufficient.

The chi square statistic is 42.61 on 31 degrees of freedom.

The p-value is 0.08

Illustration 4: Factor analysis result 1

Factor 1

Uniquenesses:

X3.1	X5.1	X5.3	X9.2
0.289	0.602	0.578	0.170

Loadings:

	Factor1
X3.1	0.843
X5.1	0.630
X5.3	0.650
X9.2	0.911

	Factor1
SS loadings	2.361
Proportion Var	0.590

Test of the hypothesis that 1 factor is sufficient.

The chi square statistic is 3.74 on 2 degrees of freedom.

The p-value is 0.154

Illustration 3: Factor analysis result 2

Factor 2

Uniquenesses:

X1.3	X4.1	X5.1	X6.1
0.240	0.382	0.710	0.253

Loadings:

	Factor1
X1.3	0.872
X4.1	0.786
X5.1	0.539
X6.1	0.864

	Factor1
SS loadings	2.416
Proportion Var	0.604

Test of the hypothesis that 1 factor is sufficient.

The chi square statistic is 0.04 on 2 degrees of freedom.

The p-value is 0.979

Illustration 2: Factor analysis result 3

Factor 3

Uniquenesses:

X3.1	X4.2	X9.5	X11.2
0.451	0.784	0.419	0.348

Loadings:

	Factor1
X3.1	0.741
X4.2	0.464
X9.5	0.762
X11.2	0.808

	Factor1
SS loadings	1.999
Proportion Var	0.500

Test of the hypothesis that 1 factor is sufficient.

The chi square statistic is 5.01 on 2 degrees of freedom.

The p-value is 0.0818

Illustration 6: Factor analysis result 4

Factor 4

Uniquenesses:

X1.1	X9.1	X11.2	X11.3
0.498	0.923	0.646	0.105

Loadings:

	Factor1
X1.1	0.709
X9.1	0.278
X11.2	0.595
X11.3	0.946

	Factor1
SS loadings	1.830
Proportion Var	0.457

Test of the hypothesis that 1 factor is sufficient.

The chi square statistic is 0.4 on 2 degrees of freedom.

The p-value is 0.818

Illustration 5: Factor analysis result 5

Factor 5

Uniquenesses:

X1.1	X1.2	X1.3	X4.1
0.831	0.465	0.217	0.433

Loadings:

	Factor1
X1.1	0.411
X1.2	0.731
X1.3	0.885
X4.1	0.753

	Factor1
SS loadings	2.053
Proportion Var	0.513

Test of the hypothesis that 1 factor is sufficient.

The chi square statistic is 5.16 on 2 degrees of freedom.

The p-value is 0.0757

Illustration 7: Factor analysis result 6

Uniquenesses:

F1	F2	F3	F4	F5
0.844	0.005	0.903	0.436	0.517

Loadings:

	Factor1	Factor2
F1	-0.329	-0.161
F2	1.003	
F3	-0.306	0.151
F4	-0.163	0.768
F5	-0.177	-0.636

	Factor1	Factor2
SS loadings	1.266	1.044
Proportion Var	0.253	0.209
Cumulative Var	0.253	0.462

Factor Correlations:

	Factor1	Factor2
Factor1	1.000	0.209
Factor2	0.209	1.000

Test of the hypothesis that 2 factors are sufficient.

The chi square statistic is 2.07 on 1 degree of freedom.

The p-value is 0.151

Illustration 8: Chi-square tests GNI per capita

1.1 Housing and urban areas

```
   1   2 3 4
1 1 11 4 0
2 0   1 1 1
3 0   0 0 0
4 0   0 0 1
5 0   0 0 1

> .Test <- chisq.test(.Table, correct=FALSE)
> .Test

        Pearson's Chi-squared test

data:  .Table
X-squared = NaN, df = 12, p-value = NA

> remove(.Test)
> fisher.test(.Table)

        Fisher's Exact Test for Count Data

data:  .Table
p-value = 0.03128
alternative hypothesis: two.sided
```

9.2 Industrial and military effluents

```
   1 2   3 4
1 0 4 12 2
2 3 0   1 0
3 0 0   0 1
4 0 2   0 0
5 0 1   0 0

> .Test <- chisq.test(.Table, correct=FALSE)
> .Test

        Pearson's Chi-squared test

data:  .Table
X-squared = 35.037, df = 12, p-value = 0.000462
```

9.5 Air-borne pollutants

```
   1 2 3 4
1 0 9 1 0
2 1 2 1 0
3 0 0 0 1
4 0 0 1 0
5 0 0 1 0

> .Test <- chisq.test(.Table, correct=FALSE)
> .Test

        Pearson's Chi-squared test

data:  .Table
X-squared = 28.301, df = 12, p-value = 0.004997
```

Illustration 9: Chi-square tests population change (%) 2010-2015

11.3 Changes in temperature regimes

```
   1 2 3 4
1 2 7 5 1
2 0 2 0 0
3 1 0 1 0
4 1 0 1 0
5 0 0 0 2

> .Test <- chisq.test(.Table, correct=FALSE)
> .Test
        Pearson's Chi-squared test
data:  .Table
X-squared = 22.349, df = 12, p-value = 0.03379
```

5.1 Hunting and collecting terrestrial animals

```
   1 2 3
1 1 9 0
2 2 0 0
3 0 1 3
4 1 3 0
5 0 0 0

> .Test <- chisq.test(.Table, correct=FALSE)
> .Test
        Pearson's Chi-squared test
data:  .Table
X-squared = NaN, df = 8, p-value = NA
> remove(.Test)
> fisher.test(.Table)
        Fisher's Exact Test for Count Data
data:  .Table
p-value = 0.002005
alternative hypothesis: two.sided
```

11.3 Changes in temperature regimes

```
   1  2 3
1 3 12 0
2 1  0 1
3 1  1 0
4 1  0 1
5 2  0 0

> .Test <- chisq.test(.Table, correct=FALSE)
> .Test
        Pearson's Chi-squared test
data:  .Table
X-squared = 18.157, df = 8, p-value = 0.02008
```

Reference

Abbitt, R. J. F., Scott, J. M., & Wilcove, D. S. (2000). The geography of vulnerability: incorporating species geography and human development patterns into conservation planning. *Biological Conservation, 96*(2), 169-175.

Agardy, T., Bridgewater, P., Crosby, M. P., Day, J., Dayton, P. K., Kenchington, R., . . . Peau, L. (2003). Dangerous targets? Unresolved issues and ideological clashes around marine protected areas. *Aquatic Conservation: Marine and Freshwater Ecosystems, 13*(4), 353-367. doi: 10.1002/aqc.583

Amend, S., & Amend, T. (1995). Inhabitants in national parks: an unsolvable contradiction? In S. Amend & T. Amend (Eds.), *National parks without people? The South American experience*. Quito, Ecuador: IUCN.

Bajpai, R., Upreti, D. K., Nayaka, S., & Kumari, B. (2010). Biodiversity, bioaccumulation and physiological changes in lichens growing in the vicinity of coal-based thermal power plant of Raebareli district, north India. *Journal of Hazardous Materials, 174*(1-3), 429-436.

Bangladesh. (2010). Fourth National Report to the Convention on Biological Diversity.

Bax, N., Williamson, A., Aguero, M., Gonzalez, E., & Geeves, W. (2003). Marine invasive alien species: a threat to global biodiversity. *Marine Policy, 27*(4), 313-323.

Bevanger, K. (1998). Biological and conservation aspects of bird mortality caused by electricity power lines: a review. *Elsevier, 86*(1), 67-76.

Bhutan. (2010). Fourth National Report to the Convention on Biological Diversity.

Brodie, J. F., Giordano, A. J., Zipkin, E. F., Bernard, H., Mohd-Azlan, J., & Ambu, L. (2015). Correlation and persistence of hunting and logging impacts on tropical rainforest mammals. *Conservation Biology, 29*(1), 110-121.

Burivalova, Z., Sekerciouglu, C. H., & Koh, L. P. (2014). Thresholds of Logging Intensity to Maintain Tropical Forest Biodiversity. *Current Biology, 24*, 1893-1898.

Cambodia. (2014a). Fifth National Report to the Convention on Biological Diversity.

Cambodia. (2014b). Fifth National Report to the Convention on Biological Diversity.

China. (2014). Fifth National Report on the Implementation of the Convention on Biological Diversity.

Clark, C. (1940). *The Conditions of Economic Progress*. London: Macmillan.

CMP. (2004). The open standards for the practice of conservation. Retrieved July 27, 2012, from CMP (Washington, D.C.) web page: www.conservationmeasures.org

Dunlop, M., & Brown, P. (2008). Implications of climate change for Australia's national reserve system: a preliminary assessment.

Emerton, L. (1997). Seychelles Biodiversity: Economic Assessment.

Forester, D. J., & Machlist, G. E. (2002). Modeling human factors that affect the loss of biodiversity. *Conservation Biology, 10*(4), 1253-1263.

Garchinbyamba, M., & Kang, H. (2013). Analyzing causes of desertification in Bayankhangai soum, Tuv province, central Mongolia. *Forest Science and Technology, 9*(2), 59-64.

Gibson, L., Lee, T. M., Koh, L. P., Brook, B. W., Gardener, T. A., Barlow, J., . . . Sodhi, N. S. (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature, 478*(7369), 378-381.

Gubbay, S. (1995). Marine protected areas—past, present and future. *Marine Protected Areas*, 1-14.

Hannah, L., Midgley, G., Andelman, S., Araújo, M., Hughes, G., Martinez-Meyer, E., . . . Williams, P. (2007). Protected area needs in a changing climate. *Frontiers in Ecology and the Environment, 5*(3), 131-138.

Hansen, A. J., Knight, R. L., Marzluff, J. M., Powell, S., Brown, K., Gude, P. H., & Jones,

K. (2005). Effects of exurban development on biodiversity: patterns, mechanisms, and research needs. *Ecological Applications, 15*(6), 1893-1905.

Harrison, R. D. (2011). Emptying the Forest: Hunting and the Extirpation of Wildlife from Tropical Nature Reserves. *BioScience, 61*(11), 919-924.

Hockings, M., Stolton, S., Leverington, F., Dudley, N., & Courrau, J. (2006). Evaluating Effectiveness, A framework for assessing management effectiveness of protected areas (2nd ed.). Gland, Switzerland and Cambridge, UK: IUCN.

Indonesia. (2014). Fifth National Report to the Convention on Biological Diversity.

IUCN-TILCEPA. (2010). Joint PAEL-TILCEPA workshop on Protected Areas Management Evaluation & Social Assessment of Protected Areas (pp. 17). Gland, Switzerland: IUCN.

IUCN. (1984). *Threatened protected areas of the world*. Gland, Switzerland: IUCN Commission on National Parks and Protected Areas.

IUCN. (2005). Threats authority file. Version 2.1. Retrieved November 6, 2012, from IUCN Species Survival Commission, Cambridge, United Kingdom http://iucn.org/webfiles/doc/SSC/RedList/AuthorityF/threats.rtf

IUCN. (2012). IUCN red list of threatened species. Threats classification scheme (Version

3.1). Retrieved July 19. 2012, from International Union for Conservation of Nature and Natural Resources http://www.iucnredlist.org/documents/June_2012_Guidance_Threats_Classification_Scheme.pdf

IUCN, & CMP. (2006). Unified Classification of Direct Threats Version 1.0. Retrieved July 19, 2012 http://www.wiser.org/uploads/file/8797a2070f0dd25dea019fa059916d5a/IUCN-CMP_Unified_Direct_Threats_Classification_2006_06_01.pdf

Japan. (2014). Fifth National Report to the Convention on Biological Diversity.

Jha, S., & Bawa, K. S. (2006). Population growth, human development, and deforestation in biodiversity hotspots. *Conservation Biology, 20*(3), 906-912.

Kazakhstan. (2014). Fifth National Report to the Convention on Biological Diversity.

Kiviat, E. (2013). Risks to biodiversity from hydraulic fructuring for natural gas in the Marcellus and Utica Shales. *Annals of the New York Academy of Sciences, 12861*(1), 1-14.

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review, 45*(1), 1-24.

Laos. (2010). Fourth National Report to the Convention on Biological Diversity.

Leverington, F., Costa, K. L., Courrau, J., Pavese, H., Nolte, C., Marr, M., . . . Hockings, M. (2010). Management effectiveness evaluation in protected areas – a global study (2 ed., pp. 89). Brisbane, AUSTRALIA: The University of Queensland.

Leverington, F., Hockings, M., & Costa, K. L. (2008). Management effectiveness evaluation in protected areas: Report for the project 'Global study into management effectiveness evaluation of protected areas': The University of Queensland, Gatton, IUCN WCPA, TNC, WWF, AUSTRALIA.

Machlis, G., & Tichnell, D. (1985). *The state of the world's parks: an international assessment for resource management, policy and research*. Boulder, CO, USA: Westview Press.

Maikhuri, R., Nautiyal, S., Rao, K., Chandrasekhar, K., Gavali, R., & Saxena, K. (2000). Analysis and resolution of protected area–people conflicts in Nanda Devi Biosphere Reserve, India. *Environmental Conservation, 27*(01), 43-53.

Malaysia. (2014). Fifth National Report to the Convention on Biological Diversity.

Maldives. (2010). Fourth National Report to the Convention on Biological Diversity.

Margottini, L. (2011). Gulf Drilling Disaster Triggers Scrutiny of Mediterranean Oil Rush.

Science, 333.

Mcdonald, R. I., Kareiva, P., & Forman, R. T. T. (2008). The implications of current and future urbanization for global protected areas and biodiversity conservation. *Biological Conservation, 141*(6), 1695-1703. doi: 10.1016/j.biocon.2008.04.025

McKee, J. K., Sciulli, P. W., Fooce, C. D., & Waite, T. A. (2004). Forecasting global biodiversity threats associated with human population growth. *Biological Conservation, 115*(1), 161-164.

Mongolia. (2014). Fifth National Report to the Convention on Biological Diversity.

Murata, Y. (2008). Engel:s law, Petty:s law, and agglomeration. *Journal of Development Economics, 87*, 161-177.

Myanmar. (2014). Fifth National Report to the Convention on Biological Diversity.

Nepal. (2014). Fifth National Report to the Convention on Biological Diversity.

Nepstad, D., Schwartzman, S., Bamberger, B., Santilli, M., Ray, D., Schlesinger, P., . . . Fiske, G. (2006). Inhibition of Amazon deforestation and fire by parks and indigenous lands. *Conservation Biology, 20*(1), 65-73.

Newbold, T., Hudson, L. N., Hill, S. L. L., Contu, S., Lysenko, I., Senior, R. A., . . . Purvis, A. (2015). Global effects of land use on local terrestrial biodiversity. [Article].

Nature, *520*(7545), 45-50. doi: 10.1038/nature14324

http://www.nature.com/nature/journal/v520/n7545/abs/nature14324.html#supplementary-information

Nolte, C., Leverington, F., Kettner, A., Marr, M., Nielsen, G., Bomhard, B., . . . Hockings, M. (2010). Protected Area Management Effectiveness Assessments in Europe: A review of application, methods and results *BfN- Scripten 271a*. Vilm, Germany: BfN.

OECD. (2013). Purchasing Power Parities - Frequently Asked Questions (FAQs). Retrieved January 25, 2013 http://www.oecd.org/std/purchasingpowerparities-frequentlyaskedquestionsfaqs.htm

Okello, M. M., & Kiringe, J. W. (2004). Threats to biodiversity and their implications in protected and adjacent dispersal areas of Kenya. *Journal of Sustainable Tourism*, *12*(1), 55-69.

Pakistan. (2014). Fifth National Report to the Convention on Biological Diversity.

Parikh, J. (1996). Consumption patterns - the driving force of environmetal stress. In P. H.

May & R. S. da Motta (Eds.), *Pricing the Planet*. New York: Columbia University Press.

Parr, C., & Brockett, B. (2008). Patch-mosaic burning: a new paradigm for savanna fire management in protected areas? *Koedoe-African Protected Area Conservation and Science*, *42*(2), 117-130.

Pauchard, A., & Alaback, P. B. (2004). Influence of elevation, land use, and landscape context on patterns of alien plant invasions along roadsides in protected areas of South‐Central Chile. *Conservation Biology, 18*(1), 238-248.

Philippines. (2014). Fifth National Report to the Convention on Biological Diversity.

Rao, P. K. (2000). *Sustainable development: economics and policy*. Oxford, UK: Blackwell Publishers Inc.

Ricketts, T., & Imhoff, M. (2003). Biodiversity, urban areas, and agriculture: locating priority ecoregions for conservation. *Ecology and Society, 8*(2), 1.

Rouget, M., Richardson, D. M., Cowling, R. M., Lloyd, J. W., & Lombard, A. T. (2003). Current patterns of habitat transformation and future threats to biodiversity in terrestrial ecosystems of the Cape Floristic Region, South Africa. *Biological Conservation*, *112*(1), 63-85.

Rubin, A., & Babbie, E. (2010). *Essential research methods for social work* (Second ed.). Belmon, USA: Brooks/Cole.

Salafsky, N., Margoluis, R., Redford, K. H., & Robinson, J. G. (2002). Improving the Practice of Conservation: a Conceptual Framework and Research Agenda for Conservation Science. *Conservation Biology, 16*, 1469–1479.

Salafsky, N., Salzer, D., Stattersfield, A. J., Hilton-Taylor, C., Neugarten, R., Butchart, S. H., . . . Wilkie, D. (2008). A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conserv Biol, 22*(4), 897-911. doi: 10.1111/j.1523-1739.2008.00937.x

Scott, M. J., Davis, F. W., Csuti, B., Noss, R., Butterfield, B., Groves, C., . . . Wright, R. G. (1993). GAP Analysis: A Geographic Approach to Protection of Biological Diversity. *Wildlife Monographs, 123*, 1-41.

Sri-Lanka. (2014). Fifth National Report to the Convention on Biological Diversity.

Tajikistan. (2014). Fifth National Report to the Convention on Biological Diversity.

Timor-Leste. (2010). Fourth National Report to the Convention on Biological Diversity.

Turkmenistan. (2009). Fourth National Report to the Convention on Biological Diversity.

Vietnam. (2014). Fifth National Report to the Convention on Biological Diversity.

White, A. T., Courtney, C. A., & Salamanca, A. (2002). Experience with marine protected area planning and management in the Philippines. *Coastal Management, 30*(1), 1-26.

Zuniga-Gutierrez, G., Arroyo-Cabrales, J., Lechuga, C., & Ortega-Rubio, A. (2002). Environmental quantitative assessment of two alternative routes for a gas pipeline in Campeche, Mexico. *Landscape and Urban Planning, 59*(3), 181-186.

Abstract in Korean

일반적으로 생물다양성 보존을 위한 기존의 연구방식은 각 각의 생물종 혹은 위협요인에 중점을 두고 접근해 왔다. 이러한 경향은 오늘날에도 계속 이어지고 있다. IUCN(세계보호연맹)-CMP(Conservation Measurement Partnership) 위협요인 분류법이 대표하듯이 생물다양성에 대한 위협요인을 다루려는 노력은 지금까지 많이 다뤄졌으나, 정작 위협요인에 영향을 미치는 근본 원인을 밝히기 위한 포괄적인 연구는 전무한 실정이다.

생물다양성에 대한 위협요인은 자연 및 인간으로 인한 요인으로 구성된다. 특히 생물다양성에 위협을 주는 요인이 주로 인간으로부터 기인한다는 것은 이미 알려져 있는 사실이다. 마찬가지로 수 많은 연구에서 개발이나 인구 압력으로 인한 영향을 지적하고 있다. 하지만 지속적인 노력에도 불구하고 위협요인에 따른 영향을 수치화하는 것이 쉽지 않았다. 그렇기 때문에 인간으로 인한 위협요인에 영향을 미치는 근본 원인을 파악하기 위한 연구 도전이 많지 않았다고 저자는 판단한다. 따라서 본 연구에서는 '주로 인간으로 인해 생물다양성에 대한 위협요인이 발생한다'는 것을 전제로, per-capita GNI 와 인구증가압력으로 대표되는 개발 및 인구 압력이

과학적으로 생물다양성에 있어서 위협요인의 근본원인임을 밝히고자 한다. 또한 IUCN-CMP 위협요인 분류법을 바탕으로 작성한 코드표를 가지고, CBD 국가보고서 내용을 분석하여 위협요인을 수치화하고 이를 근본원인 분석에 활용하고자 한다.

결과로써, 다음과 같은 다섯 가지가 위협요인(인간으로 인한)에 영향을 미치는 근본원인인 것으로 나타났다. ①자원이용, ②관광, ③석유 및 천연가스 생산, ④도시화, 마지막으로 ⑤상업 및 공업 지역 개발이 이에 해당한다. 주목 할 만한 점은 석유 및 천연가스 생산도 생물다양성 위협요인에 적지 않은 영향을 미친다는 점이다. 하지만 per-capita GNI, 도시개발, 물 및 공기 오염, 그리고 인구 압력과 hunting 외에는 개발 및 인구 요인과의 관계성이 뚜렷이 드러나지 않았다. 이러한 연구 결과를 토대로 경제성장이 기대되는 나라에서 도시개발 및 물과 공기오염에 초점을 맞추거나 인구증가률이 높은 나라에서 hunting 에 대한 대비책을 마련한다면 생물다양성에 미칠 악영향을 줄일 수 있을 것으로 사료된다. 하지만 대부분의 아시아 국가에서는 심각한 재정 및 인적 자원 부족이라는 문제를 안고 있다. 때문에 생물다양성을 조사하고 모니터링을 실시하거나,

자연 보호지역을 설립하고 운영하기 위한 지원이 이루어지지 못하게 되고 결국 생물다양성을 회복시키는 데에 있어서 어려움을 겪게 된다. 또한 법을 집행 할 수 있는 환경이 마련되지 않거나 기반시설 및 장비가 제대로 정비되지 않은 문제점도 안고 있다. 따라서 앞으로 국가적 차원에서 겪고 있는 문제들을 고려한 보다 현실적인 정책 및 제도 마련에 대한 연구가 필요할 것으로 판단된다.

주요어:

생물다양성 위협요인, 인간으로 인한 압력, IUCN-CMP 위협분류법,

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