Nuclear Energy's Role as Non-Carbon Emissions for Net Zero World Construction: Historic UN's AR6 Synthesis Report (SYR) Finalized!

Tae Ho Woo*
Department of Mechanical and Control Engineering, The Cyber University of Korea, Seoul 03051, Republic of Korea
**Corresponding author: thwoo@cuk.edu, thw_kor@hotmail.com*

***Keywords :** *nuclear, net zero, UN, IPCC*

1. Introduction

The Sixth Assessment Repost (AR6) Synthesis Report (SYR): Climate Change 2023 has been finalized by the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) [1]. This study investigates the effect of the report on global warming to mitigate climate disasters using the complex algorithm using the System dynamics (SD) method, which has been used in many areas including human and social matters [2]. Until now, there are six reports published by IPCC to mitigate global warming by the carbon-induced greenhouse effects [3-8].

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in the 1st report [3]. The 2nd report is associated with the adoption of the famous Kyoto Protocol [9]. Then, the 4th report is incorporated with the Nobel Peace Prize for disseminating the seriousness of climate change by Al Gore, former vice president of the United States [6]. In 2015, the adoption of the Paris Agreement was associated with the IPCC's 5th report [7].

It is written as a total of 8 reports during the AR6 cycle (From 2015 to 2022) for the 6th report of IPCC, where the publications on the Scientific and Technical Assessment of Climate Change are as follows,

1. Working Group 1 (WG I) Report: Climate Change Science
2. Second Working Group (WG II) Report: Climate Change Impacts, Adaptation and Vulnerability
3. Third Working Group (WG III) Report: Climate Change Mitigation
4. Comprehensive report: Integration and evaluation of the key contents of the three working group reports and the special report

In addition, there are some comparisons between AR5 and AR6 in Table 1 where some items are described for temperature standards such as the global surface temperature change [7,8].

2. Methods

The SD modeling is constructed for complex scenarios where the climate is a critical factor in the work, which is the atmospheric behavior affected by the air quality of carbon associated with global warming. It is expected to find reasonable solutions in simulations.

Ten climate mitigation strategies for global warming [10] are described for the retirement of coal plants in Fig. 1. Reflecting the endeavors of IPCC's works to seek solutions in global warming treatment, Coal Plants Retirements, Clean Energy Investment, Building Retrofit/Decarbonization, Cement, Steel, Plastic Decarbonization, Electricity Vehicles, Public Transport, Biking, Walking Increasing, Aviation, Shipping Decarbonization, Deforestation Stop, Food Loss Reduction, and More Plants Eating are Ten strategies for climate mitigations [11].

Using the SD method, the climate has the characteristics of combining many dependent variables based on the feedback of systems that complements systems thinking algorithms. The positive feedback system is calculated by the differential equations as [12],

$$A(t) = A(0) \cdot \exp(+Bt) \quad (1)$$

where $A(t)$ is the time-dependent variable, $A(0)$ is the initial variable, and B is the constant. The stock-flow structure is used as Levels and Rates in SD [13]. It is like the algorithm in the bathroom where the water flows in and out of the bathtub as,

$$Stock\ (t) = \int_0^t [A(t) - B(t)]dt + Stock\ (0) \quad (2)$$

This is the integral form for the variable flows. $A(t)$ and $B(t)$ are time-dependent variables. $Stock\ (0)$ is the quantity at the initial time. For differentiating, it is written as,

$$\frac{d(Stock\ (t))}{dt} = A(t) - B(t) \quad (4)$$

These are commonly used in SD modeling where the Vensim code is used in this work [14].

In Fig. 2, the modeling is constructed by the SD method where the climate change is analyzed by the complete algorithm. Especially, the Major Threats include disasters such as sea level rise, causalities, and so on. Three cases of Main Climate Characteristics, Climate Change Processes, and Human Activities are related to the Greenhouse Effect in Fig. 2 (a). Climate Mitigations

effect on the Greenhouse Effect to mitigate global warming in Fig. 2 (b) where the nuclear energy investment is substituted from the clean energy investment. Table 2 shows the variables. In the case of 'Increase in Impermeable Surface', the generated random number is compared with 0.2. If it is larger than 0.2, the value is 0.0. Otherwise, it is 1.0. The Boolean values are calculated by an arithmetic operation.

3. Results

Fig. 3 shows the results for the Impact of climate change [11] are shown as (a) Carbon Cycle Disturbances and (b) the Greenhouse Effect. For the importance of the greenhouse effect, the starting point is 1.0 of the importance value in Fig. 4. The graph decreases right after 2nd year and 1.05172 of importance value in the 50th year in the 'With Climate Mitigation' case which is about 4 times lower than that of 'Without Climate Mitigation' case. The values are nearly below 1.0 over the period.

4. Conclusions

In this work, the IPCC's AR6 report was analyzed as the 6th series report against global warming treatment. There are ten strategies to keep the 1.5℃ limiting path which were not in the AR5 report in 2014. There are some important points in this study. IPCC's AR6 report is analyzed by mitigating global warming. Comparisons of mitigations are described in the modeling, which could be the insight in the future. The climates are related to some nonlinear factors which couldn't be decided in quantity because there are many uncertainties. SD modeling can show successfully the nonlinear algorithm to solve the future consequences to achieve the goal of removing the atmospheric carbons.

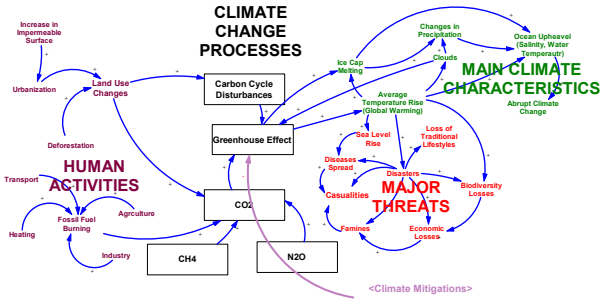
Acknowledgments

This study was supported by the Ministry of SMEs and Startups grant (RS-2023-00266376).

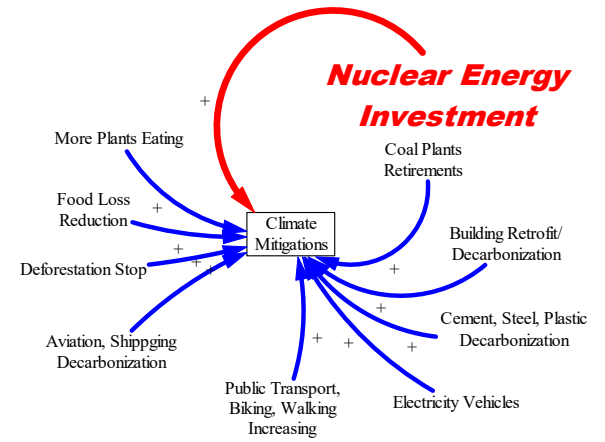
REFERENCES

[1] IPCC, SYNTHESIS REPORT OF THE IPCC SIXTH ASSESSMENT REPORT (AR6), Intergovernmental Panel on Climate Change (IPCC), World Meteorological United Nations Environment Organization (WMO), Geneva, Switzerland, 2023.
[2] SDS, What is System Dynamics? System Dynamics Society (SDS), San Diego, USA, 2023.
[3]IPCC, CLIMATE CHANGE : The 1990 and 1992 IPCC Assessments, Intergovernmental Panel on Climate Change (IPCC), World Meteorological United Nations Environment Organization (WMO), United Nations Environment Programme (UNEP), Jeneva, Switzerland, Nairobi, Republic of Kenya, 1992.
[4]IPCC, IPCC Second Assessment, Climate Change 1995, Intergovernmental Panel on Climate Change (IPCC), World Meteorological United Nations Environment Organization (WMO), United Nations Environment Programme (UNEP), Jeneva, Switzerland, Nairobi, Republic of Kenya, 1995.
[5]IPCC, Climate Change 2001: Synthesis Report, Intergovernmental Panel on Climate Change (IPCC), World Meteorological United Nations Environment Organization (WMO), United Nations Environment Programme (UNEP), Jeneva, Switzerland, Nairobi, Republic of Kenya, 2001.
[6]IPCC, Climate Change 2007, Synthesis Report, Intergovernmental Panel on Climate Change (IPCC), World Meteorological United Nations Environment Organization (WMO), Geneva, Switzerland, 2007.
[7]IPCC, Climate Change 2014, Synthesis Report, Intergovernmental Panel on Climate Change (IPCC), World Meteorological United Nations Environment Organization (WMO), Geneva, Switzerland, 2014.
[8]IPCC, AR6 Synthesis Report Climate Change 2023. The Intergovernmental Panel on Climate Change (IPCC), 2023, https://www.ipcc.ch/report/ar6/syr/.
[9]C. Tardi, What Is The Kyoto Protocol? Definition, History, Timeline, Status, Investopedia, New York, USA, 2022.
[10]J. Giannantonio, Top Takeaways from the IPCC's AR6 Synthesis Report: Climate Change 2023, ALL4 All, 2023, https://www.all4inc.com/4-the-record-articles/top-takeaways-from-the-ipccs-ar6-synthesis-report-climate-change-2023/.
[11]UNFCC, Climate Change: Causes, Impacts and Vulnerability Assessment, United Nations Framework Convention on Climate Change (UNFCCC), united Nations (UN), New York, USA, 2007, https://www.slideshare.net/ramtpiitb/hs-693-prof-sp-cc128080001.
[12]Y. Barlas, System dynamics: systemic feedback modeling for policy analysis, in Knowledge for Sustainable Development: An Insight into the Encyclopedia of Life Support Systems, UNESCO Publishing, Bonn, Germany, 2002.
[13]J.D. Sterman, Business Dynamics: Systems Thinking and Modeling for a Complex World, Irwin McGraw-Hill, Boston, USA, 2000.
[14]Vensim, Vensim, Ventana systems, Inc., Harvard, USA, 2016.

Fig. 1. Ten strategies for climate mitigations [10].

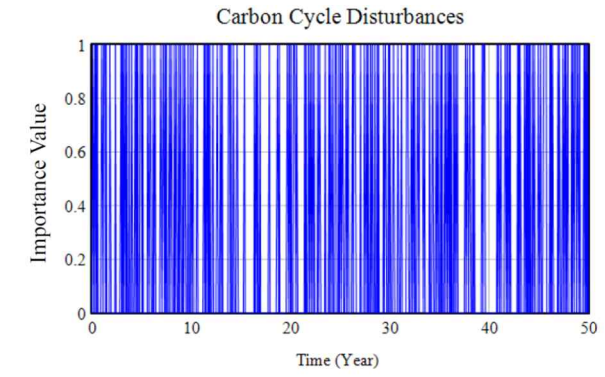


(a)

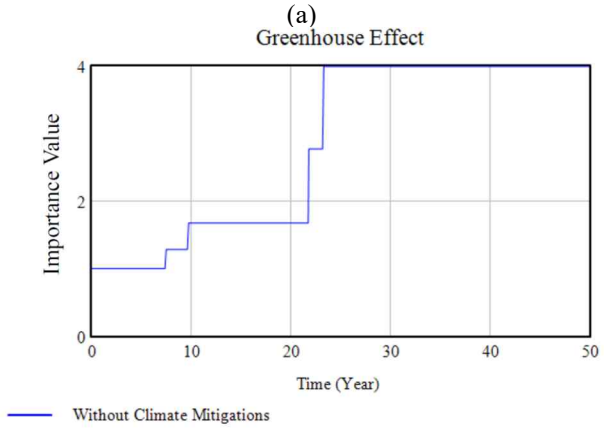


(b)

Fig. 2. Impact of climate change (a) Main Modeling and (b) Modified Climate Mitigations [11].



(a)



(b)

Fig. 3. Results for Impact of climate change [11] (a) Carbon Cycle Disturbances and (b) Greenhouse Effect.

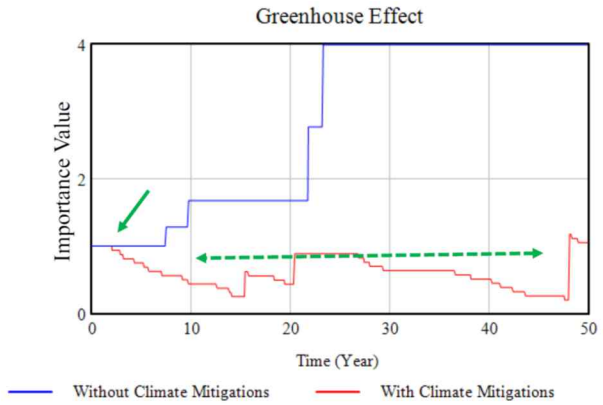


Fig. 4. Comparisons for the Impact of climate change by mitigations by Greenhouse Effect [11].

Table I: List of comparisons between AR5 and AR6.

Item	AR5	AR6
Global surface temperature change relative to pre-industrial period	0.85 °C	1.09 °C
Cumulative anthropogenic CO_2 emissions	2040 ± 310 $GtCO_2$	2400 ± 240 $GtCO_2$
International cooperation	United Nations Framework Convention on Climate Change, Kyoto Protocol Linkage	Emphasize the role of international cooperation, transnational partnerships, environmental/sectoral agreements, institutions and initiatives
Mitigation pathway (2020~2030)	Based on the 2℃ limit by 2030	(1.5℃ limiting path) 43% reduction from 2019 required by 2030, (2℃ limiting path) 27% reduction from 2019 required by 2030

Table II: List of variables.

Variable	Equation
Increase in Impermeable Surface	if then else(random 0 1 () < 0.2, 0, 1)
Land Use Changes	Deforestation * Urbanization
Disasters	"Average Temperature Rise (Global Warming)" * if then else(random 0 1 () < 0.3, 0, 1)
Greenhouse Effect	(if then else(random 0 1 () < 0.03, 0, 1) * Carbon Cycle Disturbances *CO2 * Clouds) - Climate Mitigations, Initial Value = 1.0
Nuclear Energy Investment	if then else(random 0 1 () < 0.1, 0, 1)
More Plants Eating	if then else(random 0 1 () < 0.2, 0, 1)
Electricity Vehicles	if then else(random 0 1 () < 0.2, 0, 1)