BASIC SCIENCES, EARTHQUAKES, AND SUSTAINABILITY

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Abstract

Technological advancements have brought significant changes to society in recent years. These changes have made various fields of work more complex, with increasing benefits. In turn, the importance of basic sciences such as mathematics, physics, chemistry, and biology has become even more crucial in understanding world events and applying them accordingly. A solid basic science education is the first step in dealing with this complexity. As the pace of change picks up, studies and practices that lack good basic science knowledge will become difficult to control and may lead to a misinterpretation of facts. Sustainable development aims to balance economic, environmental, and social needs to ensure the well-being of current and future generations. The United Nations' 17 Sustainable Development Goals are all directly related to the basic sciences of mathematics, physics, chemistry, and biology, with most of the topics covered being sub-branches of these sciences. Countries can achieve these goals and beyond by placing greater importance on basic sciences. Earthquakes are among the leading natural disasters in the world. Seismology, geology, geophysics, soil mechanics, structural dynamics, and material branches play a vital role in understanding the mechanisms of earthquake formation, monitoring the movement of the earth's crust, predicting and determining earthquakes, as well as building and protecting structures appropriately. Basic sciences are at the core of these branches, and equations from basic sciences are used in predicting and determining earthquake magnitude. Mathematics and science, as basic sciences, have a critical role in achieving sustainability goals by helping us understand, predict, and control developmental processes. This study emphasizes the importance of basic sciences such as mathematics, chemistry, physics, and biology in understanding earthquake problems and sustainability issues.

Keywords
Mathematical Modeling, Physics, Chemistry, Biology, Earthquake Prediction

Introduction

The Relationship Between Basic Sciences and Sustainability

Basic sciences, which include physics, chemistry, biology, and mathematics, are the branches of science that explain all the developments in the world. The progress and studies in this field demonstrate this fact. The United Nations Sustainable Development Goals consist of 17 headings, which are:1. No Poverty, 2. Zero Hunger, 3. Good health and well-being, 4. Quality education, 5. Gender equality, 6. Clean water and sanitation, 7. Affordable and clean energy, 8. Decent work and economic growth, 9. Industry, innovation, and infrastructure, 10. Reduced inequality, 11. Sustainable cities and communities, 12. Responsible consumption and production, 13. Climate action, 14. Life below water, 15. Life on land, 16. Peace, justice, and strong institutions, 17. Partnerships for the goals. On September 25, 2015, leaders from around the world gathered at the Sustainable Development Summit held in New York, where they agreed on the Sustainable Development Goals. These goals consist of 17 objectives and 169 targets to eradicate poverty and ensure the well-being of humanity by 2030. To achieve these goals, the basic sciences and their products are crucial in each target. Some headings have a stronger association with science, while others rely on it to make remarkable contributions to their fields.

Mathematics is a key aspect of this since it is crucial in medicine, dentistry, and pharmacy. The use of technology with materials in education, such as AI and robotics, is also prevalent. Technology in the medical field has cost roughly $300 billion in the past century, and this figure is expected to increase in the next five years. Mathematics and physics have had a significant influence on the creation of these tools. Diagnosis tools, including X-rays, testing apparatus, and other detectors, owe their genesis to mathematical methodologies. Moreover, the age of robotic surgery and other pieces of equipment, as well as medications outside of the manual domain, is a paradigmatic advancement deriving from chemistry and biology. Currently, AI and technology are considerably shortening the time for diagnosis and treatment.

Quality education is heavily associated with advancing technologies such as the internet, robotics, AI, big data, and others. These changes have been prominent in the last fifty years, and the pace of this very alteration has grown exponentially in the past five years. As a result, the components, assessment plans, and architecture of teaching have seen massive variations. The World Economic Forum and UNESCO predicted a shortfall of graduates due to a deficit in their qualifications, which can sit up to seventy percent. This means that a further curriculum concentrated on these modern-day technologies and abilities should be accommodated in the schooling system. Particularly, universities should establish atmospheres in which undergraduates acquire proficiency utilizing tools such as digital techniques, AI, and robotics, and those aimed at verbal, visual, and written communication, leadership, analytical, and critical thinking.

Clean water and purification demand potent utilization of disciplines such as chemistry, biology, mathematical proficiency, and physics. The analysis of usable water and the purification of wastewater utilizing bacteria and other living organisms, the transportation and dissemination of water, and the responsible dumping of wastewater are aspects that borrow significantly from physics and mathematics. All of this is independent of the development of problem-solving devices through mathematical models, the construction of mathematical models to address and remedy real-world issues, and the consequence of such modeling on the way to sustainable development. Therefore, to ensure a resolute grasp of the complexity and peculiarities of these technologies, it is fundamental for individuals to improve their fundamental knowledge of the sciences (Kundu, 2018).

Mathematical modeling plays a vital role in sustainable management practices, encompassing social, environmental, and economic studies. Most developmental challenges can be resolved with mathematical models capable of defining them. The sustainability of planet Earth depends on the science of mathematics. Other areas where mathematical modeling is used include medicine, climate change, water resources, hazardous wastes, nuclear wastes, population dynamics, and many more. Mathematical modeling helps in understanding and managing epidemic diseases, preserving biological diversity, mitigating climate change, and ensuring ocean sustainability. All these issues fall under linear and nonlinear differential equations, which can be solved using mathematical models. Mathematics plays a crucial role in evaluating and tracking sustainability objectives, forecasting in various fields, and monitoring progress. Calculations are fundamental in assessing poverty levels, comparing regions within a country, or contrasting areas to other nations. Basic sciences like mathematics are directly linked to decent employment, economic development, production, innovation, and transportation. As sustainable management practices become more complex and require scientific, mathematical, or statistical tools, mathematical modelling and systems become essential. These models, based on dynamic systems within control theory, reconcile the ecological and economic spheres using a congruent modelling strategy. Mathematical modelling is vital to solving real-world problems such as estimating India's population in 2050, understanding global warming, modelling satellite launches, controlling pollution from vehicles, fluid flow within drains, lakes, rivers, catchment areas, and more. Mathematical modeling also plays a crucial role in sustainable management practices encompassing the social, environmental, and economic aspects of development challenges. These models can solve issues such as climate change, water resources, hazardous wastes, nuclear wastes, population dynamics, and more. The sustainability of the Earth is dependent on the science of mathematics. Mathematical models also show the impact of medicine on the human system. Linear and nonlinear differential equations are used to tackle global sustainability development issues like climate change, biological diversity preservation, pollution control, epidemic disease management, and ocean sustainability (Levin, 2015).

The understanding of the physical domain, power assets, climate shift, and sustainability goals are closely related to the field of physics. The transition from fossil fuels to renewable energy sources, work in this area, and the increase in energy efficiency are all linked to physics. In addition, understanding the factors contributing to climate change is related to the core sciences. Biosphere science provides the foundation for a multitude of aspirations, such as enhancing biodiversity, controlling contagions, and improving healthcare systems. The correction of ecological degradation caused by air pollution has strong ties to biosphere science.

The Relationship Between Basic Sciences and Earthquake Engineering

Earthquake engineering is closely related to the basic sciences. To fully understand the physical mechanisms of earthquakes and investigate changes in the physical variables of the energy that causes earthquakes in time and space, it is essential to evaluate all the variables together. The physicochemical structure of earthquakes is complex, and variables such as the energy source, tectonic history, faulting, and triggering mechanism all have direct impacts. Therefore, analyzing these variables independently, in terms of time or space, is not systematic and does not provide a singular solution. Instead, it is necessary to take a multifaceted approach that emphasizes the continually evolving nature of this scientific field.

With the increase in natural disasters in recent years and a growing global population, it is clear that our disaster reduction technology is lagging behind. To address this, we must not only study new geological events but also examine as many historical earthquake examples as possible for comparison and reference. In the Middle East, earthquake engineering relies heavily on the basic sciences and covers recent natural disasters as well as events such as landslides and avalanches (Gates & Ritchie, 2007).

Earthquakes are a complex natural phenomenon that results from a transformation of energy. Some experts have likened the process to that of a machine, with energy acting as the driving force. In fact, this concept was introduced by Kasahara in the field of seismology back in 1969. However, to fully grasp the inner workings of earthquakes, it's crucial to simulate this machine and understand the physical processes involved. The severity of an earthquake is determined by its magnitude and intensity, which can be measured using various scales. One such scale was developed by Charles Richter in the 1930s, and subsequent scales have been based on his original idea. The moment magnitude scale, for example, measures the amount of energy released at the earthquake's epicenter.

Physics and earthquake engineering share a close relationship. Calculations related to earthquake engineering have been carried out using principles of physics for centuries. Over time, various engineering disciplines have emerged, considering these principles. One such discipline is rock mechanics, which is particularly relevant to earthquake engineering. It deals with topics such as frictional stress analysis, design, planning, structural dynamics, and preservation. Physics forms the foundation of earthquake engineering, enabling predictions, analyses, and efforts to reduce earthquake damage.

The occurrence of earthquakes is explained by fundamental sciences such as physics, chemistry, and biology. The accumulation of stress measurements in geological layers, where space-time dimensions are involved, is a significant factor that directly influences the intensity of earthquakes. Earthquake engineers use the basic principles of physics to determine the intensity, duration, frequency, and the region where the earthquake occurred. They provide information that other scientific disciplines can utilize. The development of physics has given rise to various subfields like wave theories, elasticity theory, geophysics, geology, and seismology, which now form the main axis of earthquake engineering.

To understand the behavior of structures during an earthquake, it is important to apply the fundamental principles of physics. Earthquake-resistant structures rely on various aspects of physics, such as structural rigidity, natural frequencies, modes, capacity design, and step calculations. These calculations require a strong foundation in physics, as complex mathematical processes are involved. Earthquake engineers use different branches of physics, including mechanics, quantum mechanics, statistical mechanics, and electromagnetism to design structures that can withstand earthquakes.

Chemistry and earthquake engineering have significant relationships. The Earth's crust composition and changes resulting from earthquakes have connections to chemical factors. For instance, the movement of the magma layer beneath the Earth's crust, which can cause earthquakes, involves a complex chemical system of various minerals and gases. Changes in gas pressure or chemical alterations in this layer can affect the occurrence, size, frequency, and impact of earthquakes. The selection of construction materials is crucial in earthquake-resistant building design, and this decision is closely related to chemistry. Cement, aggregates, and steel are materials used in building construction, and their properties, chemical reactions, and interactions with each other play a significant role in the durability of structures.

Earthquakes are also intertwined with biological changes and ecological effects. Some living organisms can detect seismic waves in advance and react accordingly by relocating or taking precautions. Changes in the natural environment due to the stress created by pre-earthquake phenomena can affect the quality of life of organisms. The timing and effects of these biological changes are important in predicting earthquakes.

Conventional parameters used to evaluate well water, spring water, and groundwater such as pH, total dissolved solids (TDS), electrical conductivity, and the presence of dissolved gases like nitrogen, argon, CO2, helium, and others, are not sufficient to predict earthquakes. However, when combined with additional changes in water chemistry, they can be useful for generating insights. Similarly, radon as a precursor becomes evident only when assessed alongside factors beyond mechanical and microfracturing, coupled with a deeper understanding of radon's release mechanisms. Unlike certain anomalies that have been sporadically detected only once before significant seismic events, changes in groundwater parameters preceding earthquakes have been consistently observed over extended periods and across various geographical regions. This offers hope that, through sustained efforts, significant strides can be made in earthquake prediction by leveraging groundwater precursors. Anthropogenic influences present challenges, but they are not insurmountable. Advancements in the field of earthquake prediction and forecasting may be on the horizon, stemming from the recognition that stressed rocks serve as sources of electronic charge carriers, specifically electrons and positive holes when subjected to stress. These positive holes have the remarkable capacity to migrate through Earth's crust over considerable distances, possibly spanning tens or even hundreds of kilometers. When these positive holes encounter a boundary between the Earth's crust and water, they initiate a sequence of chemical reactions, including the generation of free hydroxyl radicals (•OH). These hydroxyl radicals are integral to advanced oxidation processes, which can lead to intricate electrochemical reactions unlikely to be triggered by other mechanisms. An example of such a reaction is the oxidation of arsenite to arsenate, a phenomenon that holds promise as a noteworthy earthquake precursor, warranting further investigation within the domain of geology and earthquake engineering (Paudel et al., 2018).

Determining the earthquake-prone area of buildings, the impact direction, and the cross-sectional effects, as well as understanding how loads affect them are crucial steps in earthquake engineering calculations. Nowadays, computer programs are mostly used for these calculations. However, relying solely on the results obtained from these programs can be dangerous. Many extensive buildings that have been designed and approved projects have failed due to the lack of basic knowledge among engineers. Without a sufficient understanding of physics principles, engineers cannot interpret the results and recognize the mistakes made, which can lead to catastrophic results. Understanding the behavior of earthquakes and seismic accelerations in the superstructure requires a solid foundation in physics principles. The earthquake resistance, rigidity, natural frequencies, modes, damping capacity, and step calculations of structures are all based on physics principles. Calculations made without understanding these principles are prone to errors, as complex mathematical operations are involved (Şeker & Korkut, 2023).

The use of Artificial Intelligence (AI) has the potential to improve our capacity for managing natural disasters, such as earthquakes. However, there are constraints associated with its application that must be acknowledged and addressed. To fully harness its benefits, it is important to establish interdisciplinary, multistakeholder, and international collaborations aimed at setting standards necessary for its effective implementation in fields such as geology, earthquake engineering, and disaster risk reduction.

Natural disasters can have devastating consequences on both society and the environment. These disasters are caused by various natural phenomena such as atmospheric, hydrological, geophysical, oceanographic, and biological events. They pose unique challenges, especially in areas with limited resources and vulnerable populations, including women and children. Geoscientists and disaster risk reduction experts recognize the importance of addressing these challenges, as reflected in scientific literature and Sustainable Development Goals.

Incorporating innovative technologies such as AI into natural disaster management has emerged as a significant development. In fields like medicine and finance, AI has gained recognition due to advancements in algorithms, increased computational power, and the availability of extensive datasets. In the context of natural disaster management, the hope is that AI can utilize geospatial data to improve our understanding of natural disasters, optimize the speed of detection, increase the accuracy and lead times of forecasts, and enhance the effectiveness of emergency communication systems.

This commentary discusses the advantages and limitations of data collection methods and AI-driven developments in natural disaster management. It explores the complexities of modeling, such as the suitability of model architectures, evaluation criteria, and the expectations of generalizability across different regions. For example, AI-based algorithms have shown better performance than classical models in predicting earthquakes across various shaking thresholds. Similarly, in avalanche forecasting, AI algorithms achieved an 80% agreement with human forecasts, despite the inherent complexities of assessing avalanche danger.

Nevertheless, these advancements in AI-based methods are met with challenges, particularly in the absence of clear guidelines or standards to guide researchers, developers, and those tasked with implementing the resulting solutions, including policymakers, government agencies, consumers, and humanitarian organizations.

AI has made significant strides, but it is not without challenges. The lack of clear guidelines or standards to guide researchers, developers, and those tasked with implementing the resulting solutions has become a significant obstacle. This lack of guidance extends to policymakers, government agencies, consumers, and humanitarian organizations.

After validating AI-based algorithms for detecting and forecasting natural disasters, the challenge lies in effectively implementing them for disaster management. Bridging the gap between AI developers and implementers is crucial. These algorithms are often created by experts in geoscience or machine learning in academic settings, with limited interaction with stakeholders and end-users, such as governmental emergency management agencies and humanitarian organizations. This disconnect can impede the integration of AI-based solutions into disaster management strategies.

Effective cross-sectoral collaboration is a crucial factor in addressing today's challenges. For example, IBM's Operation Risk Insights platform is a successful interdisciplinary cooperation with humanitarian organizations. There are already many programs promoting these approaches, such as the Resilient America Program, which integrates AI with new data sources like social media for predictive analysis. The European Union's CLINT project brings together experts and stakeholders from various sectors to harness AI for climate services and policymaking. The African Union's Africa Science and Technology Advisory Group (Af-STAG) on Disaster Risk Reduction actively collaborates with experts worldwide to enhance risk information transmission through AI technologies. The UN Environment Programme's Focus Group on AI for Natural Disaster Management (FG-AI4NDM) works towards establishing standards for AI use in natural disaster management, ensuring a diverse range of perspectives is considered within the standardization landscape. These collaborative efforts represent a promising path forward in revolutionizing the field of geology, earthquake engineering, and disaster risk reduction through the power of AI (Kuglitsch et al., 2022).

Earthquake prediction is a difficult task as the timing, location, and magnitude of seismic events are essentially unpredictable. However, AI techniques have shown great potential in discovering patterns within data. In their study, Banan et al. (2020) review 84 scholarly research papers that explore the application of AI-based methods in earthquake prediction. The studies cover a range of AI methodologies, including rule-based approaches, shallow machine learning, and deep learning algorithms. The paper provides a comprehensive overview of the available methods and conducts a comparative assessment of their performance using various datasets and evaluation metrics. The objective is to help researchers select the most suitable techniques for earthquake prediction and identify persistent challenges and potential avenues for future research in this field.

Earthquake prediction models operate by detecting seismic indicators calculated from earthquake catalogs. However, certain precursory events, such as variations in radon gas concentration, shifts in soil temperature, and anomalous cloud formations, may occur a few days prior to an earthquake, but they do not definitively confirm an impending seismic event. P-waves and S-waves detected through seismographs serve as a means of earthquake prediction. Some nations use dedicated satellites to monitor earthquake-related parameters, aiding in the identification of potential precursors. This data is then fed into the prediction model and subjected to preprocessing, including the removal of missing values and formatting to align with classification and regression algorithms. These algorithms categorize and forecast the timing, location, and magnitude of impending earthquakes, leveraging their capacity to unveil concealed patterns within the data. AI-based methods have introduced a new frontier in enhancing the accuracy of earthquake prediction, exhibiting superior performance in comparison to alternative techniques. These advancements have the potential to significantly reduce damages, as areas of concern can be evacuated based on forecasts. This marks a notable advancement in the fields of geology and earthquake engineering (Banna et al., 2020).

As mentioned earlier in the text, the relationship between earthquake engineering and mathematics is of great importance. Earthquakes can occur in various areas, including earthquake prediction, building design, earthquake intensity measurement, and more. Predicting the effects of earthquakes, designing earthquake-resistant structures, and evaluating, reducing, and rebuilding damage caused by earthquakes are all part of earthquake engineering. Mathematics is one of the fundamental tools of earthquake engineering, along with physics. Mathematical calculations enable the calculation of earthquake intensity, performance evaluations, seismic vibration analysis, structural analysis, and statistical calculations. By considering a structure's behavior with the ground and applied seismic loads, mathematical calculations can be used to determine the safety of buildings.

Earthquake engineering comprises several branches, with engineering seismology being one of the most important. It focuses on the dynamic characteristics of structures and uses complex mathematical methods like Laplace transformations and series to analyze them. Using these calculations, the effects of earthquake loads on building elements such as mat foundations, beams, columns, and slabs can be reduced by using methods such as seismic dampers, passive control devices, active control devices, recorders, modal analysis, and spectral analysis. Mathematics plays a crucial role in predicting, calculating, designing structures, ensuring their safety, and minimizing damage caused by seismic effects.

Earthquakes result from a combination of (1) physico-chemical processes operating in fault zones that allow the nucleation of fractures and reduction of rock friction by increasing slip or shear rate, and (2) the geometric complexity of fault zones. Recent experimental findings from rock friction experiments (conducted at high speed, approx. 1 m/s sliding speed, or typical seismic sliding speeds) have led to a better understanding of potential dynamic weakening mechanisms like melt lubrication, nanopowder lubrication, etc. It is important to recognize how these mechanisms can be identified through mineralogical and microstructural studies in exposed fault zones. Field and laboratory experiments can help obtain earthquake source parameters (seismic fault strength, attenuation distances, energy budgets, etc.). Fault zone geometry and morphology need to be considered while developing realistic models of fault surfaces. Theoretical considerations for microphysical modeling of laboratory data at seismic slip rates are also presented.

Experimental data and microphysical models indicate that faults must be very weak ($\mu < 0.1$) during seismic slip. Moreover, the slip attenuation distance during seismic slip is at most on the order of a few tens of centimeters under natural conditions, which is consistent with inferences from field observations (Neimeijner et al., 2012).

The current earthquake prediction methods suffer from a high rate of false alarms, making it difficult to assess the actual occurrence of earthquakes. This lack of precision in the prediction process contributes to the catastrophic outcomes associated with earthquakes in geology and earthquake engineering. To clarify the concept of earthquake prediction, the United States National Research Council Panel on Earthquake Prediction proposed a consensus definition. According to the definition, earthquake prediction should specify the expected magnitude range, the geographic area where it will occur, and the time frame in which it will happen with enough precision to easily evaluate its success or failure. It is crucial to evaluate both failures and successes to determine the overall effectiveness of earthquake prediction and guide future directions.

It should be noted that many of the supposed precursors mentioned in earthquake forecasting literature are not reliable predictors. For instance, even the most advanced and regularly updated short-term forecasts for the Northwest (NW) and Southwest (SW) Pacific cannot be considered as credible predictions unless a specific probability threshold is established to define the areas that will be affected. Furthermore, an independent evaluation of predictions based on setting a threshold probability or probability ratio on top of daily forecasts has shown that neither method is significantly more effective than random guessing, even when the predicted aftershocks are considered successful.

Many people believe that earthquake prediction involves short-term forecasts, which offer warnings of hours to days in advance and are expected to be 100% reliable. This mindset is similar to classical oracles, and expectations and preparations for making a short-term prediction of a major earthquake in the Tokai region of Japan exemplify this. Nevertheless, we ought to ask ourselves whether there are inherent temporal, spatial, and physical characteristics in the earthquake process that could lead to alternative forms of prediction, and what measures can be taken in response to such predictions to mitigate losses.

Many researchers concentrate on predicting the specific fault segment to rupture, rather than exploring spatial prediction modes. This is exemplified by the Parkfield earthquake prediction experiment. Predicting earthquakes is a highly challenging task and there is a possibility that it may be unsolvable. The modes of earthquake rupture, which are associated with the size of the impending earthquake, can be classified based on the location of the source zone within a broader prediction range. Approaching the earthquake prediction problem in a hierarchical, step-by-step manner that considers the multiscale escalation of seismic activity leading to the primary rupture is a natural approach. This situation excludes imprecise predictions, but identifying earthquake-prone areas through pattern recognition methods is a fundamental way to pinpoint the location of a target earthquake. Additionally, the Gutenberg-Richter law suggests that the range of magnitude for prediction should be limited to approximately one unit. Otherwise, the statistics derived from real data might predominantly reflect the occurrence of smaller earthquakes, potentially leading to misleading attributions to larger events. Predicting earthquakes is as straightforward as one-two-three. Step 1: Deploy your precursor detection instruments at the anticipated earthquake site. Step 2: Detect and identify the precursors. Step 3: Gain consensus from your peers and publicly announce the earthquake prediction through approved channels.

There are instruments called "precursor detection instruments" which are currently being used worldwide. Routine seismological observations are collected into databases such as the US GS/NEIC Global Hypocenter Data Base. These records are accessible for general use. Some "precursors" have already been detected, including reproducible intermediate-term algorithms like the M8 and MSc algorithms. Furthermore, some earthquakes have already been publicly predicted. The ongoing real-time monitoring of global seismic activity is aimed at predicting major earthquakes in the intermediate term. This has a substantial history. Several significant earthquakes have been predicted successfully, while some predictions have proven inaccurate. It is noteworthy that the real-time monitoring would have to encounter four consecutive prediction failures to reduce the confidence level achieved below 95%, an eventuality that appears unlikely. The results warrant special attention, as the estimates use the most cautious measure of alarm volume, accounting for the empirical distribution of epicenters. The accomplishments in pattern recognition for designing reproducible algorithms that predict large earthquakes and the confirmed statistical validity of these predictions over the past decade affirm several fundamental paradigms: 1. Seismic premonitory patterns exist; 2. The formation of earthquake precursors for years involves extensive fault systems; 3. These phenomena exhibit similarity across a wide range of tectonic environments; 4. These phenomena possess a universality that is observed in other complex nonlinear systems (Kossobokov, 2004).

The use of mathematical modeling in predicting earthquakes has advanced to the point where it can now be applied to social forecasting as well. Just like in geology and earthquake engineering, politics and its outcomes are also variables that can be estimated and forecasted. Studies have shown that, as with the output of mathematical modeling, certain index values must be met before a presidential candidate can be elected successfully. For instance, if a candidate garner 8 index points out of 13, then the chances of being elected successfully are 55%. It's amazing to see how basic sciences and earthquake engineering can become a social construct that even impacts our daily lives and who governs our countries. This knowledge and science could open tremendous opportunities for our society in the future.

Conclusion

The significance of Basic Sciences concerning earthquakes and sustainability goals is made clear by the explanations above. With the rapid advancements in technology and other fields across the world, every sector becomes even more complicated. Some developments, such as climate change, make it difficult to predict the occurrence, impact, and damage of natural disasters. These factors add to the complexity of work in all fields. A solid understanding of basic sciences, including mathematics, physics, chemistry, and biology, is crucial in coping with the chaotic and complex world we live in. Therefore, the importance of basic sciences is further emphasized. Only by receiving a good education in basic sciences can we deal with the complexity of this world.

Mathematical modeling, based on basic sciences, is the application of mathematics to solve real-life problems. Sustainable development, on the other hand, entails development that meets the needs of the present without jeopardizing the ability of future generations to meet their own needs. Mathematical modeling plays an important role towards sustainable development in understanding, predicting, and controlling the development process. Most of the issues covered under 17 headings in the United Nations Sustainable Development Goals are related to the basic sciences of mathematics, physics, chemistry, and biology. Most studies conducted in this field focus on sub-branches of basic sciences. By prioritizing basic sciences, countries can achieve these goals in 2030 and beyond.

Basic sciences have a direct correlation with disasters, particularly earthquake disasters. It has been observed that seismology, geology, geophysics, soil mechanics, structural dynamics, and material branches play a crucial role in understanding the formation mechanisms of earthquakes, monitoring the movement of the earth's crust, predicting, and comprehending the occurrence of an earthquake, constructing, and safeguarding appropriate structures. Additionally, equations from basic sciences are employed to predict and determine earthquake magnitude.

Mathematics and science are vital in understanding, predicting, and controlling developmental processes, and they play an essential role in comprehending disasters such as earthquakes. Project engineering calculations have been made for most of the buildings destroyed in the Kahramanmaraş, Hatay, Adıyaman, Malatya and Adana earthquakes that occurred on February 6 in our country. Despite this, one of the most important reasons for the collapse of buildings is the insufficient knowledge of engineers in basic sciences such as physics, mathematics and chemistry.

A thorough understanding of basic sciences such as mathematics, chemistry, physics, and biology is crucial for successfully predicting earthquakes, taking precautions against them, conducting post-earthquake studies, and achieving the United Nations' sustainability goals.

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He was born in Giresun in 1956. He graduated from the Faculty of Civil Engineering at Istanbul Technical University (ITU) in 1980. He completed his Master's degree in 1983 and his Doctorate in 1988 at the same university. In 1980, he started his career as an Assistant at the Sakarya State Architecture and Engineering Academy. In 1988, he became an Assistant Professor in the Civil Engineering Department at ITU Sakarya Faculty of Engineering, and later became an Associate Professor in 1994 and a Professor in 2000. He served as the Vice Rector starting in 2002, focusing on "strategic planning, quality, education and training, and investments" at the university. In 2010, he was appointed Rector of the same university. During this period, he led the establishment of the University Management System to facilitate national and international processes in Higher Education Quality, Institutional Evaluation in Universities, and Accreditation. He also managed the Turkey Excellence Award, EFQM Excellence Award, Global Excellence Award processes, EUA IEP, YÖKAK external evaluation processes, and nearly 50 program accreditation processes with national/international accreditation agencies. Additionally, he is a member of the AFAD Earthquake Advisory Board, Deputy Chairman of the YÖK Vocational Qualifications Institution, Chairman of the Interuniversity Council Education Commission, Full Member of the Turkish Academy of Sciences (TÜBA), and a council member of TÜBA. Since April 1, 2018, he has been serving as the President of the Higher Education Quality Council.